TWENTY-FIRST YEAR OF PUBLICATION.

ROYAL ASTRONOMICAL SOCIETY

THE JOURNAL OF SCIENCE,

AND ANNALS OF

ASTRONOMY, BIOLOGY, GEOLOGY, INDUSTRIAL ARTS, MANUFACTURES, AND TECHNOLOGY.

(MONTHLY, FORMERLY "THE QUARTERLY JOURNAL OF SCIENCE.")

Vol. VI. (THIRD SERIES)
No. CXXVIII.

AUGUST
1884.

CONTENTS.

ARTICLES.	PAGE
1. A Description of the Process of "Hydraulic Mining" in California, with Explanations concerning the Origination of Gold-bearing Alluvium there, and Elsewhere. By GEORGE O'BRIEN	441
2. Observations on Twilight ..	451
3. On Electricity and its Present Applications. By W. FRASER, A.M., M.R.C.S. Eng.	456
4. Emerald-green: its Properties and Manufacture. By ROBT. GALLOWAY, M.R.I.A.	467
5. Significant Nomenclature. By WM. JOHN GREY, F.C.S. ..	472
ARTICLES—*continued.*	PAGE
6. Thoughts on Imitation. By J. W. SLATER	475
7. Observations of Bright Lines in the Spectra of Fixed Stars	480
ANALYSES OF BOOKS.	
The Law of Sex	484
Sleep-Walking and Hypnotism..	487
A Treatise on Earthy and other Minerals, and Mining	489
The Atheistic Platform	490
Corpulence, and its Treatment on Physiological Principles &c., &c. ..	492
CORRESPONDENCE	497
NOTES	499

LONDON:

3, HORSE-SHOE COURT, LUDGATE HILL.

Where Communications for the Editor and Books for Review may be addressed.

PRICE ONE SHILLING AND SIXPENCE

[The Articles and Reports in this Journal are Copyright.]

THE FUEL OF THE SUN.

By W. MATTIEU WILLIAMS, F.R.A.S., F.C.S.

8vo., Cloth, Price 7s. 6d.

The Author endeavours to demonstrate that the atmosphere o our earth is but a portion of the universal medium of space which the earth has accumulated by its gravitation. The atmosphere of the Sun is calculated on this basis, and it is shown that the original evolution of solar light and heat is a necessary consequence of the atmospheric accumulation due to his gravitation.

A continual supply of fresh solar fuel is further shown to result from the combined action of planetary disturbance and the Sun's motion of translation; and thus both the origin and the maintenance of solar and stellar heat and light are explained.

All the details of photospheric phenomena,—the spots, the faculæ, the mottling "granulations," &c., &c., follow as incidental consequences; as also the prominences, the corona, the zodiacal light, and the zones of meteors and aërolites.

The atmospheres of the planets are calculated on the same basis; and this reveals a consistent explanation of the observed meteorology of the inferior planets, the surface phenomena and specific gravity of the superior planets, and the rings of Saturn.

The phenomena of the nebulæ are shown to be necessary results of the atmospheric accumulations of certain modifications of star clusters, or great solar systems; and an explanation of the connection between solar phenomena and terrestrial magnetism is suggested.

The whole argument is based upon known and well-established facts, and unaided by any hypothetical assumptions of imaginary materials or forces.

LONDON: SIMPKIN, MARSHALL, & CO.

In Royal 8vo. cloth, price 3s .6d. (post free, 3s. 10d.),

MICROSCOPICAL MANIPULATION.

By W. T. SUFFOLK, F.R.M.S.

Illustrated with Forty-nine Engravings and Seven Lithographs.

Chapter I.—Construction of Microscope. Chapter II.—Mechanical Processes. Chapter III.—Mounting Objects Dry and in Balsam. Chapter IV.—Mounting Objects in Fluid. Chapter V.—Illuminating Apparatus. Chapter VI.—Polarised Light. Chapter VII.—Drawing and Micrometry. Appendix.

LONDON: E. J. DAVEY, Boy Court, Ludgate Hill, E.C.

A High-Class Spiritualist Journal.

LIGHT:

A WEEKLY JOURNAL DEVOTED TO THE HIGHEST INTERESTS OF HUMANITY BOTH HERE AND HEREAFTER.

"LIGHT! MORE LIGHT!"—*Goethe.*

The Contents of the paper comprise:—(1). Original Articles on the Science and Philosophy of Spiritualism. (2). Records of Facts and Phenomena, both Physical and Mental. (3.) Miscellaneous Literature connected with the movement, including Poetry and Fiction. (4). Reviews of Books. (5). *Resumé* of the Periodical Press, both British and Foreign, devoted to Spiritualism and allied subjects. (6). Questions and Answers.

Price 2d., or 10s. 10d. per annum, post free.

London: E. W. ALLEN, 11, AVE MARIA LANE, E.C.

.S.

earth is
accumu-
l on this
eat is a
vitation.
from the
nslation;
heat and

ulæ, the
; as also
eors and

and this
e inferior
nets, and

s of the
or great
enomena

facts, and
forces.

N.

s.

Processes.
Mounting
er VI.—
dix.

HEST
AFTER.

e Science
ena, both
with the
. *Resumé*
lism and

E.C.

XUM

THE

JOURNAL OF SCIENCE.

AUGUST, 1884.

I. A DESCRIPTION OF THE PROCESS OF "HYDRAULIC MINING" IN CALIFORNIA,

WITH EXPLANATIONS CONCERNING THE ORIGINATION OF GOLD-BEARING ALLUVIUM THERE, AND ELSEWHERE.

By GEORGE O'BRIEN.

OUR knowledge of the primitive operations of the aboriginal inhabitants of the globe in pursuit of gold is barely traditional, as we are only aware that from very early times the precious metal was collected and highly prized by them, and that they chiefly extracted the visible gold, which existed in prodigious quantities on, or closely beneath, the surface of the earth, and of its being particularly abundant in Asia and Africa. But we can draw more positive conclusions as we survey remains of the rude but effective contrivances used by them in later, but still remote, periods, with full evidence as to the extent of their operations, in the numerous perpendicular shafts located at short distances from each other, over large areas of auriferous gravel in India, as well as from precisely similar memorials of ancient workings which remain also further demonstrations, in the abandoned "hill diggings," and shifted beds, and beds of rivers, in Peru, South America, flowing between the sea and coast ranges of the Andes, descending in a north-easterly direction to the River Amazon, and that their much-coveted and enormous productions were the accumulated riches of the Incas, transferred as spoils of war to their Spanish conquerors in the sixteenth century. And for

similar explorations in the same class of depositions we have the experiences of our own times, and which explain by comparison all the previous operations alluded to. Thus in the year 1849, after the cession of the northern portion of Mexico to the United States of North America, the rich mineral district of California was at once invaded by hardy and intelligent bands of mining adventurers from all parts of the world, who, with little other means at their disposal but pick, shovel, and pan, soon fell upon the productive bars of rivers and rich ravines where the gold was trapped, derived from its original birthplaces, where it had been sparsely disseminated, to be dispersed by the subsequent disintegrations and denudations of the mountains themselves, and deposited in a disengaged form for the first comer; and so perfect were sometimes these concentrations, in certain localities where water once streamed, that, divested of its earthy matrix, the cleansed pure metal was found deposited, detained by its superior specific gravity, on the bare rock, and only hidden from vision by a slight covering of vegetable mould. In this manner, as an example of such concentration, a "pot" or "find" (in mining parlance) to the value of £10,000 was collected in a space of 15 square yards, or within the limits of a particular "mining claim," at the foot of Mokulumne Hill, in a southern county of California, soon after the territorial transfer from Mexico. And in search of such locations we must account for the numberless shafts which still exist both in India and Peru, and sometimes sunk within a few feet of each other, passing through the alluvium to a depth of 40 feet to the bed rock.

These mining adventurers soon extended their explorations over the other recently acquired territories, and built Virginia city, the capital of Montana, with the gold derived from the alluvium of a river channel which they excavated; and its inhabitants were the founders of an institution called the Vigilance Committee, with "Lynch law," and by it ruled supremely for many years. But their surface diggings, by the manual operations alone of multitudes, were soon exhausted in every direction, and then their energies and powers of invention were dedicated to discover and explore deeper and more permanent depositions, along the western slopes of the Sierra Nevada, the Andes of the Western Territories, and which originally were without doubt several miles higher than they are at the present time,—probably 20,000 feet above the sea-level,—and of which, or whatever superior elevation they formerly had, the greater portion of

it has already been removed, by the continuous natural action of centuries, to form there, as elsewhere, the plains and prairies of the earth, burying and diverting by the mutation the ancient river system, whose sources of supply were consequently extinguished by the removal of these altitudes. These denudations and subsequent depositions have been caused by alternations of temperature and combined action of air, water, and time since the creation of the world; and powerful demonstrations of these transformations instruct us in all directions, if we care to observe them. Thus in "Little Cottonwood" ravine, in the Wasatch range of mountains in Utah Territory, lie isolated, in the centre of the valley, huge masses of metamorphic granite, some blocks of which weigh individually thousands of tons, and were dislodged from the hills—which on either side are of limestone formation—with no visible granite in them, having been undermined by the removal of their pulverised basis by denudation, and which is the material now forming the table-lands, the foundation of Salt Lake city. The blocks of granite, having alone resisted the atmosperic changes, were precipitated into the valley beneath, and the Mormons are now constructing their cathedral church from these granitic remains.

The melting of the snow which formerly capped all these ranges of mountains furnished the water that once flowed in the extinguished channels of ancient rivers, and whose now diverted waters were also the powerful agent to assist in causing these marvellous alternations; and by the means of hydraulic mining we can advance our feeble knowledge on the subject. These mighty changes have gradually been accomplished, and the accumulated denudations of the mineral zones have defended themselves by stratas of crystallised silicates of quartz of various thicknesses, and thus in places beneath such system of defence, or by their own concretion, have preserved in many localities a thickness of from 500 to 600 feet of conglomerate; but without this necessary cementation its further removal is very certain when again attacked by water. And an example of this continuous process is very observable in "Death Valley," Lower California, where a width of about 100 miles has been filled up from the hills to the gulf of same name, invading and occupying its former bed; and this activity is still proceeding, and a temporary formation of table-land above it is in course of removal, although already overgrown with forest trees, which are toppling over the side which is being attacked. But eternal snow now only covers a small portion of these

sierras, and a period of comparative repose may be expected, as the distribution has already been far advanced by the excessive reduction of the mountains.

The deep and extensive depositions which I now attempt to describe attracted the early attention of the mining adventurers, and were called "hill diggings," but not being properly understood were therefore not immediately operated upon, and remained in abeyance, whilst the lower, richer, and more manifest alluvials endured. They were designated "blue gravel," the colour being due to the action of sulphuret of iron and other salts, the cementing auxiliaries requisite to form the hard conglomerate, and on exposure to the atmosphere changes colour to yellow and violet, losing also its firmness by oxidation.

The "great blue lead" is another important mining term, and designates the alluvium found reposing in a well-defined channel on the bed rock, being the well-worn path of an ancient river; and it is obvious that the material in these channels should be richer than the general mass beyond their limits.

"Rim rock" is the boundary line of the banks of the old channel, and, like the bottom, is well worn and corrugated by the running water into cavities and "pot-holes," where the force of the stream eddied. The width of these channels varies from 60 to 400 feet, and the cement near the rim and bottom is always richer than elsewhere. The wider and deeper channels generally course from N. to N.W. The richest and most explored belt of gold bearing alluvium in California lies between the South and Middle Yuba Rivers, commencing near Eureka, in Nevada county, and extends downwards to Smartsville and Timbuctoo, in Yuba county, a distance of 40 miles, and from amongst snowy mountains the country falls gradually from where the ravines or cañons are cut by the actual rivers, which are 2000 feet beneath the auriferous gravel and region near Smartsville, and 2000 feet above the Yuba River, where snow is unknown, and near its terminus the ancient river bed courses more westerly than it does above it, and crosses Yuba below Timbuctoo, where the auriferous depositions disappear. The whole distance of 40 miles has been ransacked by the earlier adventurers, and around the village of Timbuctoo was a centre famed for its wonderful yield of gold, obtained chiefly in the ravines, in holes and depressions in the bed rock. These hollows detained the concentrations of the denudated alluvium from the altitudes, and were generally closely beneath the surface, and by such guidance and means of discovery the miners

traced the gold up the ravines to their sources in the lofty mounds and deposits, or hills of cemented conglomerate, near Eureka, in Nevada county, and by constructing canals from a higher level began the new system of "hydraulic mining" and washing, and gradually extended their operations over the area of the metallic zone mentioned, of 40 miles long by 20 wide, using the Yuba River below Timbuctoo to receive and discharge the tailings, or refuse from their operations. The result in gold was considerable, but the system is from its violent nature difficult to control, by presuming to handle and remove such huge depositions in order to collect the richest material. The idea was bold, being an anticipation of Nature's operations; but the equitable disposal of the "tailings" in a cultivated country is impossible, as the silt runs down the rivers, creating banks and bars in their channels, obstructing navigation and agricultural arrangements.

General Description of Hydraulic Mining.

The first work to be accomplished, after calculating that the amount or value of the material to be operated upon is sufficient to guarantee the cost of the undertaking in general, is the construction of a canal or canals, to convey the requisite volume of water from the fountain-head, and of sufficient elevation to command the ground to be worked upon, having also in view the levels of the necessary tunnels and shafts as outlets for the discharge of the gravel through them, these being engineering operations requiring much skill and labour to avoid useless after cost.

Aqueducts of considerable elevation have to be constructed across deep valleys, and the speculation is at all times problematical, as the ground cannot be properly tested until the water arrives upon it, and disputes may arise between the shareholders of the canal and the mining company, ending frequently in the one devouring the other, unless the two interests be quickly amalgamated.

The starting-point should be the lowest level, or "Bed rock," on the white cement in the ancient channel, which is probably the original silt collected in it, and is harder than the conglomerate above it, which is more easily removed. The courses of these beds can be easily traced by landmarks and indulations, and occasional exposures of the bed rock at low levels; also trial shafts are sunk in various places in search of it, to a depth of 100 feet, passing through blue gravel. The grades of these beds are not steep, being

from 10 to 40 feet per mile as of an ordinary river, and the calculated thickness of the alluvial conglomerate is about 600 feet in many places across the ridge between the South and Middle Yuba River across the Columbia. The power of the water for the operation is dependent on a given volume deposited in a reservoir, and at sufficient elevation above the points of discharge, as on this depends its effectivity to tear down the gravel. It is delivered to the miner by huge pipes made of wrought iron, and laid down to follow the curvatures of the surface of the ground; and the pipe I now treat of, belonging to the Excelsior Water Company, has a diameter of 40 inches on a length of 6000 feet, and 20 inches on the rest of its length of 3000 feet, being 9000 feet in all; and this large pipe forms an inverted syphon across a valley, following on the gravel, to the top of the hill into the reservoir.

These pipes offer advantages over wooden aqueducts for spanning chasms, and also to avoid coursing the sides of valleys; being also cheaper to construct in general, and less liable to accidents from fire and storms, and have the convenience for conveying the water from point to point, as the work of excavation advances, necessitating the removal of portions of the aqueduct forward. The watershed, or reservoir, of the Excelsior Company embraces the valley of the South Yuba and its affluences, and the entire cost of its eight amalgamated canals was 750,000 dollars.

The rainfall during three years in the mountains averaged 49 inches annually, whilst the medium in the same period did not exceed 20 inches in the plains beneath. The height of the reservoir above the tailing, or Yuba River, is 393 feet; and the height of the head above the floor, or outlet sluice-tunnel, of the Blue Gravel Mining Company was 197 feet.

The exact quantity of water required to wash every class of gravel is difficult to estimate, but no quantity or pressure would be excessive if properly arranged. The measurement of water is effected by miners' inches, by allowing it to flow from the reservoir of the seller to the purchaser through a box 10 or 12 feet square, with divisions to obtain a quiet head, with a slide or opening capable of adjustment to any required measure: thus an opening of 25 inches by 2 inches, with a quiet head of 6 inches above the middle of the orifice, would give 50 inches, or about 89,259 cubic feet of water, flowing during ten hours per day, being an amount necessary for a first-class operation. The capability of the Excelsior Canal, in rainy seasons, reached to a delivery in twenty-four hours, to the various mining companies, of 21,120,000 cubic

feet of water, or 8000 miners' inches; and the value of the water paid for by the Blue Gravel Company in forty-three months, ending November 9th, 1867, was 157,261 dollars, being at the rate of 15 cents of a dollar per miners' inch: and the proportion of water used to wash down 989,165 cubic yards of gravel was 17,074,758 cubic yards, or 17¼ cubic yards of water to 1 cubic yard of gravel; and when at work the quantity of gravel daily moved was 1298 cubic yards, and the estimated cost to move one cubic yard of gravel was 5 and 7-10th cents of a dollar. But in the face of contingencies the Blue Gravel Company moved 1,000,000 cubic yards of gravel in four years, or at the rate of 250,000 cubic yards per annum, and the cost of washing each cubic yard stands thus:—

	Cents.
Cost of water, at 15 cents per miners' inch	5·77
Cost of labour, gunpowder, sluices, and superintendence	16·10
	21·87

Or 21¾ cents of a dollar per cubic yard.

Thus the gravel should contain gold to the value of 22 cents of a dollar per cubic yard to cover cost, and the value of the gravel referred to ranged from 20 to 45 cents per cubic yard; and the cost of work done in shafts and tunnels, in the said Blue Gravel Company's Mining claim, reached 100,000 dollars. But with the cost of the necessary canals, paid for by the Excelsior Water Company apart, the total cost amounted to about 1,000,000 dollars, and we must note that the latter company sold water to other mining companies.

The gross yield in gold of the Blue Gravel Company in four years was 837,399 dollars, and in the year 1866 the returns from the Blue Gravel Company paid all the costs of the developments; but in 1867 assessments were paid by the owners to meet the deficiency arising from the cost of sinking two new shafts, and driving fresh tunnels on the lowest levels, which evidently contain on the bed rock the richest concentrations.

In smaller mining adventures of this description, involving less capital, large profits have been made in the gold-bearing zone treated of, by also not having invested in costly canals, which would not have repaid the latter investment; and thus it is evident that the water companies are dependent blindly on the prosperity of the miners.

I will now more minutely describe the actual mining operations:—The mining ground being selected, a tunnel is

projected from the nearest and most convenient ravine, so that the starting-point on the bed rock towards the face of the ravine shall approach the centre of the material to be removed at a gradient of 1 in 10 to 1 in 30. The dimensions of such tunnel are usually 6 feet in width by 7 in height, and continuing in contact with the hard river-bed, for the greater ease of excavation, collection of gold, and conservation of quicksilver amalgam.

These tunnels vary in length from a few hundred feet to a mile, and some of the longer ones occupying from one to seven years in execution, at a cost of from 10 to 60 dollars per foot of frontage. The tunnel of the Blue Gravel Company, with length of 1358 feet, cost in labour alone 70,000 dollars, but it could now be driven for 35,000 dollars, as skilled labour is cheaper now than then. The grade in this tunnel is about 12 per cent, and the end of the tunnel is designed to be 170 feet of elevation, and reaching to a point beneath the surface of the gravel which is being operated upon, and where a shaft or incline is sunk to or through the bed rock or gravel, until it intersects the tunnel. The object of this laborious operation is obvious, as the long tunnel becomes a sluiceway, and through the whole length of which sluice-boxes are laid, for the double motive of carrying off the material and saving the gold, and for this purpose a trough of strong planks is placed in the tunnel, 2½ feet wide, and with sides high enough to contain the stream. The pavement of the trough is generally laid of blocks of wood 6 inches in thickness, cut across the grain, and placed on their ends, to the width of the sluiceway. The wooden blocks are usually alternated with sections of stone pavement, the stones being set endwise, and in the interstices between the stones and wooden blocks quicksilver is distributed, and as much as 2 tons of this metal is required to charge a long sluice. The water in the canal is brought by aqueducts, or other means, to the head of the mining ground, having an elevation of 100 to 200 ft. above the lowest level of the mining ground, and is finally conveyed to it by iron pipes, sometimes sustained on a strong incline of timber.

These pipes are of sheet iron, of adequate strength, rivetted at the joints, and measure from 12 to 20 inches in diameter, and communicate at the bottom with a strong prismatic box of cast-iron, on the top and sides of which are openings for the adaptation of flexible tubes, made of very strong fabric of canvass, strengthened by cording, and terminating in nozzles of metal of 2½ to 3 inches in diameter. From these nozzles the streams of water are

directed against the face of the gravel to be washed, exercising incredible effectivity.

The volume of water employed varies of course with the work to be done; but it is not uncommon to see four such streams acting simultaneously on the same bank, each conveying from 100 to 600 inches of water per hour,—1000 miners' inches being equal to 106,600 cubic feet of water per hour, constantly exerting its force under a pressure of 90 to 200 pounds to the square inch, varying with the height of the column.

Under the continuous action of this enormons force, aided by the softening power of the water, large sections of the gravelly mass are dislodged, and fall with great violence, the *débris* speedily disintegrating and disappearing under the resistless force of the water, and is hurried forward in the sluices to the mouth of the shaft, down which it is precipitated with the whole volume of turbid water. Boulders of 100 to 200 lbs. in weight are dislodged and shot forward by the impetuous stream, accompanied by masses of the harder cement which meet in the fall, and by the concussion from the great boulders the crushing and pulverising agency required is found to disintegrate it. The heavy banks, of 80 feet and upwards, are usually worked in two benches, the upper never being so rich as the lower, and also less firm, and therefore worked away with greater rapidity.

The lower section is much the most compact, as this stratum on the bed rock being strongly cemented resists great pressure, and even sometimes the full force of the streams of water, until it has been loosened by gunpowder or other explosives. For this purpose adits are driven in on its foundation-point of from 40 to 70 feet and more from the face of the bank, and drifts are extended at right angles therefrom to a short distance on each side of the adit, and in these drifts a large quantity of gunpowder is placed (from 1 to 3 tons), and fired at one blast, having been previously built in with masonry. And in this manner the compact conglomerate is broken up, and then the water easily completes its work. Sometimes in the soft upper strata the system of tunnels is extended, as in a coal-mine, by cross alleys, leaving blocks which are afterwards washed away, and then the whole mass settles, and is disintegrated under the influence of water. The wooden sluices in the tunnels already described are often made double for the convenience of "cleaning up" one of them, whilst the other remains in action. The process of cleaning up is performed according to the quantity and richness of the material worked upon,

at intervals of twenty to forty days, and consists in removing the pavement and blocks from the bed of the sluice, and then gathering all the amalgam of gold and rich dirt collected, and replacing the blocks in the same way as at first. Advantage is taken on this occasion to reverse the position of the blocks and stones when they are worn irregularly, or substitute new ones for those which are worn through. The mechanical action of the washing process on the blocks is of course very rapid and severe, requiring complete renewal of them once in eight to ten weeks. Some miners prefer a pavement of egg-shaped stones set like a cobble-stone flooring, the gold being deposited in the interstices. Most of the sluiceways are, however, paved with rectangular wooden blocks, with or without stones as described. Standing at the mouth of one of the long tunnels in full action, any person unaccustomed to the process is struck with astonishment, amounting almost to terror, as the muddy mass sweeps onward, bearing in its course the great rolling boulders, which add their din to the roar of the water, the whole being precipitated down a series of falls, at each of which it is caught up again by new sluices of timber, lined like the first, and so onwards and downwards many hundreds of feet until the level of the river is reached, at a distance of about a half mile or more from the mouth of the first tunnel.

At each of these new falls of 25 to 50 feet the process of comminution begun in the first shaft is carried on, and a fresh portion of gold obtained. Rude as this plan of saving gold appears to be, more gold is procured by it than by any other method of washing yet devised for this process of work, and the economical advantages obtained by it cannot be surpassed, as it would be impossible to handle such vast quantities of material in any other way, and we can compare the cost of washing and handling a cubic yard of auriferous gravel by it as follows :—

	Dollars.
By manual labour with the pan	15·00
,, ,, with rocker	3·75
,, ,, with the long tom ...	0·75
By the hydraulic process...	0·15

But this process, even if effective or profitable as a mining operation, may be prejudicial to the interests of the general public, if conducted on a large scale, as the vast quantity of material which it so suddenly removes is merely shifted into the shallows beneath, to be re-distributed by every freshet to

points lower and lower down until it reaches the sea-coast, creating bars at the mouths of rivers in its course, and changing the hydrography of harbours—as it has done with the Bay of San Francisco by its silt.

The hills behind, torn up and washed by the gold miner, are abandoned as desolate and irredeemable; and the costly canals, constructed with peculiar conveniences for mining purposes, eventually fall into disuse from being too expensive to maintain or alter for general agricultural uses.

130, Fenchurch Street, London, E.C.,
May 14, 1884.

II. OBSERVATIONS ON TWILIGHT.

WE must first here complain of the want of a word which exactly covers our meaning. We might have said "Observations on Dawn," but this term is by a general convention limited to the glow in the sky which precedes sunrise, excluding that which follows sunset.

THE remarkable atmospheric phenomena which were witnessed in most parts of the world during the last winter have, as our readers know full well, given scope for much discussion; but, oddly enough, for some time no one raised the necessary preliminary question touching the normal colouration of the sky at morn and eve. At last the thought occurred, both to theorists and observers, that without a precise knowledge of this normal colouration all inquiry as to the abnormal display of the last season was in want of a firm basis. Were the aërial pageants described by "Our Special Correspondents" merely an intensification of what has always been witnessed under cloudless skies, or were they something novel and totally different?

It might indeed seem strange that, in a scientific age like the present, hundreds of observers were not at once prepared with an answer; but the observations required can be made to advantage only under skies fairly clear from cloud and

smoke, and in situations where the heavens are visible down to the horizon.

Fortunately two sets of extended and systematic observations of the evening and morning skies are in existence. The one series, published in the "Zeitschrift der Œsterr. Gesellschaft für Meteorologie," was made by Dr. G. Helmann, in Spain, during the years 1875 and 1876.

The author made, in the first place, determinations of the position of the sun at the beginning of the morning, and at the end of the evening twilight. He finds that the altitude of the sun below the horizon at the end (or the beginning in the morning) of astronomical twilight, though generally assumed at 18°, is not constant, but has a very distinct yearly period with a maximum in winter and a minimum in summer. This altitude is also greater for the morning than for the evening twilight, and is closely connected with the relative moisture of the air with which it increases. This relation to moisture determines probably the difference between the winter and the summer twilight, as well as for that between morning and evening. The same consideration will doubtless explain the fact that the depth of the sun below the horizon for evening twilight is greater in high latitudes than in low ones. Thus at Athens the yearly mean is 15·9°; whilst in the south of Spain and on the Atlantic, between 18° N. lat. and 20° S. lat., it is 15·6°. It is also smaller in inland districts than on the nearest seas. These points, however, require to be confirmed by further observation.

Not less important than these measurements of the sun's altitude are the observations made on the physical progress of the twilight in which a great number of physical changes are combined to form a typical image. In Spain, at least, the optical phenomena of twilight form two distinct classes, that of the dry and that of the rainy season. These two differ, however, mainly in intensity, so that we may here confine our attention to one form,—that of the wet season,—as the more splendid and the more manifold.

When the sun has still an altitude of 4° there appear along the entire horizon various faint colourations. In the west there is a delicate yellow of about ½° in altitude, and above that a light green of about 1°, whilst above the sun, up to about 50°, the sky is of a shining light blue, of a rather elliptical form. In the east there appears a deeper green, of only 1° in altitude and 60° in azimuth.

When the sun descends to 1° the green on the western horizon reaches an altitude of 20° without becoming more

intense; beneath this green, along the horizon, is an orange-yellow stratum of about 3°, which on its lower side begins to change into rose, brownish red to purple-violet, and extends from south to north. In the east the green becomes more intense, and rises up to 6°, whilst immediately on the horizon there appear faint rose-colour and yellow of about 2° in altitude.

When the sun has gone down the green in the eastern sky extends up to 9°, the yellow to 6°, and the full rose to 4°. The latter colour is more intense on its lower side, and fades away into an ill-defined stratum of deep steel-blue of ¼° in altitude—the beginning of the earth's shadow.

In the western sky the rose-colour has decreased; the yellow takes a more orange tint; the green increases in intensity, whilst the pale blue descends to about 45°.

Important changes now take place in the east. When the sun is about ¾° below the horizon the deep steel-blue appears as a segment of about 1° in altitude and 75° in azimuth. The superimposed rose has become deeper, and extends to 10°, whilst the yellow and green have generally entirely disappeared.

As the sun sinks deeper the rose colour takes a more purple tone, and the margin of the dark segment turns violet, whilst this segment itself becomes lighter, and changes from a steel-blue to an ash-grey. These colourations of the eastern heavens above the earth's shadow are known as the "counter-dawn," and vary in their altitude with the moisture of the atmosphere, extending higher as it increases. On an average the boundary arc of the earth's shadow can be observed up to an altitude of 15°; the segment then extends in azimuth for 150°, when the sun is 4·6 below the horizon. The superincumbent rose disappears generally at an altitude of 25°, whilst the sun has descended to 4·9 below the horizon. The so-called "civil twilight"—as distinguished from the astronomical twilight—is then at an end.

In the western heavens the orange-yellow band of 3° in altitude remains unaltered; the brownish red below it disappears entirely, and the green extends only to 8°. When the sun is 3·8° below the horizon the sky takes a rosy cast up to 25°; this colour becomes more decided and extends, so that a rosy red segment of about 40° is superimposed upon the lower strata, and attains its greatest intensity of colour when the sun has sunk to 4·3°, at the spot where the first appearance of colour was observed. This first rosy light sinks rapidly downwards, whilst the lower strata vary little, and when the sun has sunk to 6° it has in general quite disappeared.

Now the arc in the western sky which bounds the illuminated segment begins to be very distinctly perceptible. When the sun is 6° below the horizon it is about at the altitude of 75°. For 170 degrees along the western horizon extends the orange-yellow stratum, of 2½° in height; above it lies a green band of double the width, whilst the rest of the illuminated segment is a whitish blue. The boundary arc sinks rapidly downwards, and when the sun is 10° below the horizon it is scarcely as many degrees above. Sometimes a second, but fainter, rosy light can be seen in the western sky, but of less extent and shorter duration than the first. When the sun has sunk to 11½° every trace of red colour has vanished from the western sky, and the sharply-defined luminous segment hastens down to the horizon.

Still with the descent of this segment the phenomenon has not always reached its end. There sometimes occur later whitish colourations in the western sky, and whitish segments, which, however, never display any trace of colour. On one occasion a luminous appearance of 6° altitude was observed when the sun was already 23° below the horizon.

The phenomena observed during the dry season in Spain are inferior to those described, both in intensity of colour and in extent.

The phenomena of the dawn observed in Germany differ widely from those recorded in the south of Spain. In the latter country the phases are more distinct than in Germany. The succession in time is more definite, and the strata of different colour are more distinctly marked off from each other; the boundary between the light segment and the dark sky is very decided.

On the other hand, with the exception of the counter-dawn, the duration and the extent of the colouration are greater in Germany. As regards the colours, there prevails the difference that in Spain green is almost invariably seen in all shades, which is rarely the case in Germany. On the other hand, in Germany the red colourations of the Spanish heavens take a more flesh-coloured and purple tone, and the violet colours seem deeper. Further, in Spain there exists a greater difference between the twilight phenomena of summer and winter than in Germany.

In England we need scarcely say that, as a rule, the phenomena are too much complicated by smoke and cloud to admit of useful study.

At an earlier date—in 1864—Prof. von Bezold made a careful study of the phenomena of ordinary twilight, and published his results in "Poggendorff's Annalen" (vol. cxxiiii.,

p. 240). His memoir, however, though inserted in a journal so constantly consulted by men of Science, appears to have passed unnoticed. Of this oversight the notices of the phenomena of last winter gave abundant proof. Had Prof. von Bezold's paper been referred to the world would have seen that the displays in question were simply an intensification of the normal evening afterglow, and would not have rhapsodised anent electric discharges, the north light, &c. The author's memoir would further have afforded a starting-point for a more complete study of the progress and the peculiar features of these phenomena. Our readers will not fail to remark the general agreement between Prof. von Bezold's observations and those of Dr. Helmann.

The former meteorologist describes the following phenomena as to be observed every morning and evening if clouds do not interfere :—

A luminous segment appears on that side of the heavens where the sun is below the horizon (*i.e.*, in the east in the morning, and in the west at eventide). It is separated from the higher parts of the sky by a peculiar light zone. Above this zone the heavens have a blue or purple colour, and below it are seen yellow, orange, and on the horizon even brownish red tones.

At the opposite side of the heaven appears the dark segment which is simply the ash-coloured shadow of the earth, which, as long as it is merely a few degrees above the horizon, contrasts sharply with that part of the sky still (or already) illuminated by the sun,—the so-called counter-dawn.

There is also a faintly luminous circular disc of considerable diameter (at the time of its greatest intensity), and of a rose- or pale purple-red colour. This the author speaks of as the "purple light." It appears above the luminous segment some time before sunrise or after sunset, in such a manner that the lower part of the disc appears to be concealed behind the luminous segment. The centre of the disc, in the evening twilight, goes down very rapidly, whilst at the same time its radius increases, so that at the last the boundary of the disc coalesces with that of the segment. The impression is as if the purple light was gliding down behind the illuminated segment. The purple light seems to play the part of an image of the sun, much magnified, but indistinct in its outlines. At the time of its greatest intensity the light generally increases very decidedly, so that objects which shortly after sunset were no longer distinguishable are again recognised. This is especially the case

with objects at the side of the horizon opposite the luminous segment. Such objects, which were previously sharply illuminated by the setting sun, and were then shadowed by the dark segment, appear at this time once more bathed in a faint reddish light. The maximum of this second illumination occurs in the Alps when the sun is 4° or 5° below the horizon. The centre of the purple light is at this time about 18° above the horizon, whilst its upper limit may rise to an altitude of 40° to 50°.

As the purple light vanishes behind the luminous segment there appears at the opposite side of the heavens a second dark segment. Soon, also, as the first luminous segment descends, there appears above it a second, not readily distinguishable from it, and if the sky is very clear there is sometimes perceived *a second purple light*, and therewith a repeated increase of light, so that objects on the opposite side of the horizon are illuminated for the third time.

The occurrence of two distinct periods of red (rosy or purple) tones, which was dwelt upon by a number of observers as something characteristic of the twilights of last winter, is therefore a normal phenomenon, though rarely witnessed in such intensity.

The excitement which the recent sunsets produced were especially due to the unusual intensity of this second "purple light," which on some occasions seemed to surpass the first one both in extent and splendour.

III. ON ELECTRICITY AND ITS PRESENT APPLICATIONS.*

By W. Fraser, A.M., M.R.C.S. Eng.

(Concluded from page 409.)

MATTER, as it exists in the ether or chaos, is probably in its simple or atomic, and not in the molecular form, as it for the most part appears in the earth. We know that Electron *alone* does not conduce to the union, but, on the contrary, to the dispersion or repulsion of the

* Read at the Aberdeen Philosophical Society, February 5th, 1884.

particles of matter. Indeed it is quite possible, by means of electricity, to loose the molecular attraction of different kinds of matter for each other, and to reduce them to their elementary form, as was done in the notable case of Sir Humphry Davy's discovery of the metallic bases of the alkalies and their allies. It seems to require the presence of gravitation—that is to say, the attractive force of a large mass of matter—to enable Electron to exert those chemical powers which constitute so important a part of his properties.

Thus, then, the Earth, in its rapid journey through the ethereal ocean of space, like the other innumerable orbs that are circulating there, so acts upon that portion of ether that is sufficiently within the sphere of its gravitating influence (or probably within a distance somewhat beyond the circuit of the atmosphere, or 45 miles) as to admit of chemical—that is to say, molecular—combinations and aggregations of matter being brought into existence in such a condition as to be retained by the attractive power of the planet, and thus added as a permanent and continually augmenting increment to its constitution.

Speculating upon the possibility, or the probability of this hypothesis being true, it may be interesting to make an attempt to calculate the amount of increment that would thus be continually added to the mass of our Earth.

The elements required for such a calculation are—1st, the diameter of the Earth, with its atmosphere, or (say) the range at which its attractive power would counterbalance the dispersive power of electricity; 2nd, the mean distance of the Earth from the Sun; 3rd, the time of the Earth's year, or revolution round the Sun; and 4th, the proportion of matter that is contained in ether,—or, rather, the proportion of matter that can be wrested and precipitated from ether by the chemical and gravitative forces under the influence of which it is brought by the Earth's passage through it.

All these have been pretty exactly agreed upon by astronomers, except the last, although it is not improbable that even it too may be ascertained in time. But if it may be allowable to hazard an estimate of it, no one, I think, would say that, whatever may be the absolute proportion of matter in ether, one grain as the reducible portion of it,—that one grain to the cubic mile, that is to say one grain to the thousand millions of cubic feet, would be too large a proportion to assign, and we will solve the problem upon this assumption.

The mean diameter of the Earth is 7912 miles; height of the atmosphere 45 miles; consequently the diameter of the Earth and its envelope is 8002 miles, and the area of its diametrical section would be—

$$\frac{8004^2}{2} \times 3{\cdot}1416 = 50{,}315{,}870 \text{ of miles.}$$

Distance of the Earth and Sun, 92 millions of miles; therefore 184 = the diameter of Earth's yearly circuit round the Sun. This multiplied by 3·1416 gives 578,054,400 as the circumference or length of the annual circuit. This again multiplied by 50,315,878, the area of the Earth's section, gives 29,002,310,043,428,000 as the number of cubic miles in cylinder made by the Earth in its annual course round the Sun. This divided by 1,565,800, the number of grains in a ton, gives 1,857,980,378 as the number of tons annually brought within the attractive power of the Earth, and as the possible annual addition to its mass. Spread over the globe, with its 197,000,000 of square miles, this would yield about 9·43 tons to the square mile. Allowing 6080 feet to the mile, a square mile would consist of 36,966,400 square feet. This divided by 9·43 tons, or 147,862,400 grains, would give 0·31 gr. per square foot as the possible amount of matter depositable on the Earth; or 31 grains, if we suppose a cubic mile of ether to contain 100 grains of matter. At this rate it would require fifty thousand years for the addition of one ton—say a cart-load—per square mile of matter being added to the surface of the Earth.

The greater part of the matter would probably be in the form of water and other fluid substances, which would find their ultimate place of deposit in the ocean, and would not make much recognisable addition to the material of our globe. It is possible, too, that the whole of the ether thus moleculated does not become incorporated with the Earth. A portion of it lying next to the outer boundary of the imagined cylinder may probably, though sufficiently within the power of the Earth's gravitation as to have its atoms brought within chemical attraction, not be sufficiently near it to be drawn to its surface, and it may thus either drift away in some other direction, or remain in equipoise like the Moon, and, also like it, circulate with the Earth round the Sun.

The foregoing reasoning, if applicable to the Earth, must of course also be so to all the other planetary bodies, as well as to the suns or stars of the whole universe, thus

affording a glimpse of the stupendous scale on which the theory of development or evolution in this department may be applied. And, as it is believed by astronomers that the stellar system to which we belong is—independently of its other motions—drifting in some to us unknown direction through space, it follows that new and unexhausted fields of either—"untrodden fields and pastures ever new"—are becoming continually accessible, as the pabulum from which God's universe, or family of worlds, receive their nourishment and growth.

The creation of worlds may thus be understood to be a gradual, continuous, and never-ceasing process; and we can easily believe that among the streams of cosmic dust or stones drifting through space, which must have become concreted or gravitated together from the material atoms of ether, gravitation will still further unite them into larger and larger masses, as, in their motion through space, they come within reach of each other's attraction; and thus it will happen that some large and always enlarging ones will come to assume the rank of planets or planetoids, as we actually find that they *are* now doing in our own solar system. This mode of genesis, too, combined with their rotary motion, will sufficiently account for the almost perfect sphericity of the heavenly bodies.

This long digression—if we can call it a digression—on the subject of cosmogony has mainly arisen, as you may recollect, from the sight of Mr. Crookes's radiometer, and the speculation that so suggestive an instrument is calculated to give rise to.

Having made acquaintance with Electron in two of the forms which he exhibits himself, we may now view him in another and almost as important an aspect, that of heat. Nearly all his operations on matter are attended by a motion or vibration of its atoms resulting in, and in fact constituting, what we call heat. The great Genie himself seems gradually to disappear after putting his subject materials into a state of tremulous motion, which gradually subsides, with results more or less observable. He himself may either go into some new arrangement of the materials, or else vanish into surrounding space, though of course he can never be lost or annihilated.

Heat is undoubtedly the most familiar attitude, and the most useful and indispensable form, in which Electron can be viewed; but the purposes he serves, and the benefits he confers on the world, in this character, are so well known and appreciated that it is unnecessary even to enumerate,

much less to describe them. The analogy, nay the identity, of Electron and heat can be experimentally and otherwise shown in a variety of ways; but there is not time to do more than allude to this interesting department of the correlation and mutual convertibility of physical forces.

Let us for a moment change the metaphor so long kept up, and, by using the magician's power, transform our Genie into a wild steed of the Desert, careering at his own wayward will through the prairie and the forest,—dangerous and difficult to come to close quarters with,—admired for his beauty, power, and speed, yet feared and avoided because so untameable and intractable; but when once a material bridle is imposed upon him his speed is greatly subdued, and he becomes the means of carrying man along with him, and of revealing to him all the beauty, grandeur, and wonders of the world. When still further subdued, harnessed, and accoutred, he not only diffuses happiness and life all around him, but can be made to perform a variety of most useful and admirable work, far surpassing in quality and value that of any other creature within the power of man.

Electricity, Light, and Heat may be said to be a unity in trinity, recondite and mysterious to us, but not altogether incomprehensible,—a type or analogy, may we not say, of that greater and still more incomprehensible mystery, the dogma of the Divine essence, which forms an important part of the Christian creed, and which it may well encourage and justify us in believing, even although its full comprehension may be beyond our imperfect powers.

Whatever may be thought of the marvellous and beneficent powers of this great Genie, as I have attempted to describe them, in reference to the *Cosmos*, there is a department of the work assigned him by his Creator which is to us (I mean to medical men) as important, if not even more interesting and wonderful. I allude to the services he performs in regard to the *Microcosmos*, and in the development and the vital action of all living creatures, bearing, as these of course do, upon the physiological and medical aspects of Anthropology. On some of the mysteries of these subjects it is probable that there will fall in time a share of the light which his scientific cultivation is now throwing on other subjects of human interest and utility. But into this department I shall not attempt at present to enter.

The functions of Electron—lying, as many of them do, in the border-land between spirit and matter, have given occasion of late to a contention regarding the respective claims of superiority due to spirit and matter, in carrying

on the operations of the world. Leaving the religious and higher aspect of the subject, bearing on the soul, untouched and unaffected, it may be argued on this point that the property of the living body implied by the terms irritability and contractility may be said to lie at the root, and to be in truth the main test and indication, of life. It is the first and the last of the vital actions of the living organism, manifested in the embryo long before consciousness begins, and remaining for some time after death in the heart and other parts, even when separated from the body. This property is undeniably due to the presence of the neura, or nervous power, which is developed and transmitted by the combined action of the organic mechanism, and it is through the medium of Electron in this form that the brain-power, the feelings, the senses, and in fact whatever may be said to constitute the life of the animal, are maintained. It in truth may claim to be the *ipse ego* of the individual, rather than the bodily receptacle which is inhabited by it. It is true that the two are inseparable and indispensable to each other, and that they act and react on each other in many ways that are to us inscrutable; but the moment the body loses the power of maintaining and transmitting the necessary supply of its animating spirit their complete separation ensues, and the result is death, dissolution, decomposition, and dispersion of its materials. Was it not an unfortunate boast that Dr. Tyndall made when he said that "we can discern in matter the promise and the potency of all terrestrial life"?—meaning to imply that it is independent of any higher agency than what is inherent in itself. It seems to me, on the contrary, that matter is like clay in the hands of the potter, and that God makes use of some intermediate agent or agents, electricity especially, or by whatever other name it may be called, which is not necessarily nor perhaps universally inherent in matter, to carry on His operations in the world; and it is by this power, in fact, that all things are kept together in their present position and arrangement. Were *it* withdrawn, by the Almighty Creator, the property of cohesion would cease; all things would fall asunder into dust, and would probably be scattered into space like the sand or dust in the Desert.

Yes! the supremacy belongs to spirit, and not to matter. All the admirable and elevating works of art, of poetry, literature, and science; all the inventions and discoveries of man, his heroic achievements, his virtues, his religious and philanthropic enthusiasms; these, and it must be added also all their opposites of a malign description, are the

result of spiritual influences—literally of spiritual influences —residing in and energising his person. And all the infinitely more admirable and beautiful forms, both animate and inanimate, in which the material of the world is moulded are the work of that infinitely greater Spirit who predominates and rules over all.

In His government of the universe God has chosen to endow the great spirit Electron with attributes in some degree similar to some of those belonging to Himself, and He has given him potencies in accordance with these attributes; but behind, and upholding, and above them all, there dominates God's own supreme existence and will. Indeed it is impossible to conceive that matter itself, even though acted upon by all the natural or spiritual influences we know of, could mould and fabricate itself into the infinite and yet normal varieties of forms and substances, both living and inanimate, which we see around us.

On the contrary, the living world of which we form a part presents everywhere a never-ceasing miracle of Almighty power and wisdom, although our bodily eyes cannot see the hand that performs the miracles, and the sublime significance of which we fail to comprehend only from its very familiarity and our own innate selfishness and want of spiritual discernment. Thus says Tennyson :—

> "Flower in the crannied wall,
> I pluck you out of the crannies!
> Hold you here, root and all, in my hand,
> Little flower; but if I could understand
> What you are, root and all, and all in all,
> I should know what God is, and man is."

If he is a fool who has said in his heart that "there is no God," by what other name shall we call those who say or insinuate that Electron is all the God that they can recognise as being required in the world; as if a being, however powerful, whom man can force to obey his commands, as his submissive servant, could at the same time be the Sovereign Lawgiver of the Universe. The idea is heathenish and absurd. It is in kind, though not in degree, as much idolatry, or a breach of the first commandment, as the worship of stocks and stones, or of the sun, moon, and stars, or even of heroes or demigods, or of the classical deities of the ancients. Their reasoning in the matter ought rather to be—"If a servant or minister in the economy of Nature has been endowed and entrusted with such attributes and powers, how infinitely more powerful and highly endowed must be the Creator Himself, the source of all this power!"

In connection with this subject, it is only a few years since there raged a long and vehement controversy on what was called spontaneous generation, one party affirming and the other denying that the forces of Nature alone, more especially Electricity, can originate life and organisation in dead matter. But, after years of laborious and well-directed experiment and investigation, the conclusion acquiesced in by all but a few of the most prejudiced partizans is that not even the minutest monad can be produced, except from a parent or previously existing individual of the same kind. God's method, however, and His ordained laws in the never-ceasing and exuberant creation and evolution—to use the new term—of all living things, are beyond the reach of our penetration, notwithstanding the gradual advances that are apparently being made in this direction by *savants* and theologians. Such are "the *depths* of the riches both of the wisdom and the knowledge of God; how unsearchable are His judgments, and His ways past finding out!"—Rom. xi., 33.

As a fair specimen of the reasoning and drift of those who support the idea of spontaneous generation, I shall quote the words of an article on the "Relation of Darwinism to other Branches of Science," by Mr. Ball, the Astronomer Royal for Ireland, in the November number (p. 83) of "Longman's Magazine":—"At the outset of Darwin's theory," he says, "we encounter a very celebrated difficulty. His theory requires life to begin with, but how did that life originate? I need hardly remind you of the celebrated controversy which has taken place on this subject. It has been contended that life can never be produced except from life, but just as stoutly has the opposite view been maintained. Can it be possible that the wondrous and complex phenomena known as life are purely material? Can a particle of matter, which consists only of a definite number of atoms of definite chemical composition, manifest any of those characters which characterise life?" . . . .

"Unusual, indeed, must be the circumstances which will have brought about such a combination of atoms as to form the first organic being. But great events are always universal. Because we cannot repeatedly make an organised being from inert matter in our test-tubes, are we to say that such an event can never once have occurred with the infinite opportunities of Nature? We have in Nature the most varied conditions of temperature, of pressure, and of chemical composition. Every corner of the earth and of the ocean has been the laboratory in which these experiments

have been carried on. It is not necessary to suppose that such an event as the formation of an organised being shall have occurred often. If in the whole course of millions of years it has once happened, either on the land or in the depths of the ocean, that a group of atoms, few or many, have been so segregated as to have the power of assimilating outside material, and the power of producing other groups more or less similar to themselves, then we have no more demands to make on the 'Theory of Spontaneous Generation.' The more we study the actual nature of matter the less improbable will it seem that organic beings should have so originated."

All this seems to me to be only a *petitio principii*, or begging of the question, which there is absolutely no ground for acceding to. It reminds one of the boast of Archimedes:—"Give me a fixed place to stand upon, and I will move the world." "Concede to me," these reasoners say, "that matter can form and fashion itself into a living being, and I will dispense with your God, and depose him from his throne of supremacy." The premiss, if it does not mean this, at all events tends to lead some of its upholders to this and other conclusions which are opposed to the first principles of religion. Such conclusions, however, would be a mistake, even although the premises were proved to be true, for these would by no means do away with the irresistible and unavoidable recognition of an all-pervading, unceasing, and intelligent energy presiding over and throughout the universe.

As a safeguard against the dangerous and atheistical tendencies referred to, we should, in accordance with the instinctive promptings of our own nature, of all nature, and of reason and revelation, believe in God as the Creator and Governor of the Universe; and in gratitude for all that we owe to Him we ought, in the words of Christ's summation of the moral law, to love Him "with all our heart, and with all our soul, and with all our mind." But if scientists choose to make their abode in the cold shade of Agnosticism, or the still colder, darker, and more inhospitable region of Atheism, the loss and damage will be to themselves and to those who adopt their belief—a belief which, if it became general in any country, would, as has been proved by the past history of the world, destroy the basis on which its moral government is founded, and sooner or later bring degradation, misery, and ruin in its sequence.

Given life and organization, given their inseparable combination with Electron,—*but given by whom?*—and we must

admit that the latter plays a most important part in the use and the functions of the powers and attributes of all living beings. But without these postulates, and the conditions necessary for their existence, Electron would be but a blind and reckless, however powerful and all-pervading, a spirit. In the case of any planet, or say that of our own moon, for instance, which is believed to be so destitute of water that whatever portion of this it may contain is drawn by gravitation, and retained in the interior, so that it cannot appear upon the surface; and the absence of this indispensable element of animal and vegetable life would account for the arid, dismal, and death-like appearance which our pale-faced satellite, without any indication of a change of seasons, exhibits when viewed through the most powerful telescopes. *Which she at present presents*, I say, because if the hypothesis suggested be true it is possible that in the course of ages a sufficiency of water may be moleculated and attracted by the moon's own power of gravitation, to supply her with enough of this vital element to enable her, by the will or fiat of God, and through means of Electron, to become at last adapted for and endowed with such a variety of the tribes of animal and vegetable life as that which now enriches and adorns her suzerain, if not also her parent, the Earth.

The Darwinian doctrine does not necessarily lead to Atheism, and it is after all only a theory, admirable, ingenious, and suggestive in its way, but far from being so reliably and in every point true as to have the right to supersede and stamp out the old and universal beliefs which have hitherto governed mankind.

In conclusion, it may be said that Electricity as a science has now passed its stage of infancy and childhood, and is entering upon that of youth and adolescence. Long the plaything and pet of philosophers and medical men, for whose nursing and education it has hitherto brought them but scanty return, it has now grown into importance in a social, industrial, financial, sanitary, legislative, and legal point of view, and has consequently fallen under the protection of the State, and the control of financiers, lawyers, inventors, mechanicians, and speculators, and is expected by many to prove an *el Dorado* to those who have the skill and the Spirit to take possession of the hidden treasures which Electron, like Aladdin's Genie of the Lamp, has in his keeping. But it is quite possible, if not indeed probable, that if the noble Genie be overdriven and hounded on by a band of mercenary and unscrupulous men, he may, like

Samson, when forced to grind and make sport for the Philistines, bring down their financial structures in ruin on the heads of many of them,—a disaster which indeed has already occurred in several instances.

The form of allegory, or slightly interrupted allegory, in which this paper has been cast is of course not like a scientific, or logical, or deductive treatise. It is, and professes to be, nothing more than a semi-fabulous and romantic account of the matter on which it treats. By a wave of its magic wand it sweeps away doubts and difficulties, and fills up gaps or dangerous and defective places which stand in its way. As Browning says—

> "It brings the invisible into play,
> By letting the visible go to the dogs."

By an instinctive stroke of the imagination it fills in whatever is wanting to render its narrative as life-like, truth-like, and acceptable as possible; and yet it is quite possible that it may convey the elements of truth as really as many a dry and laborious philosophical dissertation. By the quaint and grotesque points of view in which it presents the subject, it tends to bring out new features and aspects of it, which might be overlooked in the ordinary light of scientific treatment.

And there is another point of view in which some might be disposed to regard it favourably. If not in accordance with the most recent views in Theology, it is at least in harmony with the older and orthodox idea of the personality of God. It strikes the same key-note of impersonation, and is in accordance with the style of language employed in the Bible, and with the way in which an old Hebrew prophet might have declaimed "Sed eheu quam magno intervallo" on such a subject. Nor is it out of harmony with the mode of expression still made use of, and still most readily understood, by the great mass of mankind regarding God's operations in the world.

IV. EMERALD-GREEN*: ITS PROPERTIES AND MANUFACTURE.

By Robert Galloway, M.R.I.A.

THE poisonous effects of wall-paper stained with emerald-green (aceto-arsenite of copper) appears to be a very favourite topic in many journals; it is continually re-appearing in one form or another in different publications, especially medical ones; there has recently appeared a short reference to it under the title, "The Poisonous Effect of Wall-paper." As some years ago I became practically acquainted with its properties and manufacture, a few observations on these subjects may not be without interest.

In the paragraph referred to, it is stated that the poisonous effect of this pigment cannot be *entirely* due to its mere mechanical detachment from the paper. This writer therefore attributes the poisonous effects to the formation of the hydrogen compound of arsenic, viz., arseniuretted hydrogen (AsH_3); the hydrogen, for the formation of this compound, being generated, the writer thinks probable, "by the joint action of moisture and organic matters, viz., of substances used in fixing to walls papers impregnated with arsenic." In some of our chemical manuals, Dr. Kolbe's "Inorganic Chemistry," for example, it is also stated that arseniuretted hydrogen is formed by the *fermentation* of the starch-paste employed for fastening the paper to the walls. It is perfectly obvious that the fermentation of the starch-paste must cease after a time, and therefore the poisonous effects of the paper must likewise cease if its injurious effects are caused by the fermentation. I do not think that arseniuretted hydrogen could be formed under the *conditions*, for the oxygen compound of arsenic is in a state of combination, and the compound is in a dry solid state and not in solution, and the affinities of the two elements—arsenic and hydrogen—for each other are so exceedingly weak that they cannot be made to unite directly except they are both set free at the same moment in presence of each other. Further, for the formation of this hydrogen compound by the fermentation of the starch, or by the growth of minute fungi, the *entire* compound must be broken up, and therefore the pigment would become discoloured; but aceto-arsenite of copper—

$$[3CuAs_2O_4 + Cu(C_2H_3O_2)_2]$$

* This substance is also known by the name Schweinfurt green.

is a very stable compound not readily undergoing decomposition, and is consequently a very permanent colour. It has also been not unfrequently stated that the injurious effects of this pigment are due to the arsenious oxide volatilising from the other constituents of the compound. This volatilisation would likewise cause a breaking up of the entire compound, and would consequently cause a discolouration of the paper; but the volatilisation of this arsenic compound is in every respect most improbable.

The injurious effects, if any, of this pigment must therefore be due to its mechanical detachment from the paper; but has it ever been conclusively proved that persons who inhabit rooms the wall-paper of which is stained with emerald-green suffer from arsenical poisoning? If it does occur, then the effects of what may be termed homœopathic doses of this substance are totally different from the effects which arise from larger doses. During the packing of this substance in its dry state in the factory, clouds of its dust ascend in the air, and during the time I had to do with its manufacture I never heard that any of the factory hands suffered, nor did I suffer, from arsenical poisoning. If there is any abrasion of the skin the dust produces a sore, and also the delicate lining of the nostrils is apt to be affected. It is in this way it acts in large doses; I am therefore very sceptical as to its supposed poisonous effects when wall-paper is stained with it.

Different methods are given in works on Chemistry for the manufacture of this pigment, but as they do not agree in every respect with the method which was followed in English colour factories some years ago, it will be as well, for the full elucidation of the manufacture of this substance, to briefly recite some of these methods before describing the one that was, and probably is still, in use; and I will afterwards describe a method which I invented, and which is practically superior to any other, both in the rapidity with which the colour can be formed, and for producing it at a less cost.

It is stated in "Watts's Dictionary of Chemistry" that it is "prepared on a large scale by mixing arsenious acid with cupric acetate and water. Five parts of verdigris are made up to a thin paste, and added to a boiling solution of 4 parts or rather more of arsenious acid in 50 parts of water. The boiling must be well kept up, otherwise the precipitate assumes a yellow-green colour, from the formation of copper arsenite: in that case acetic acid must be added, and the boiling continued a few minutes longer. The precipitate then

becomes crystalline, and acquires the fine green colour peculiar to the aceto-arsenite." I do not know from personal knowledge, but I have always understood that the copper salt employed in its manufacture in France is the acetate. This would account, in my opinion, for the larger crystalline flakes in which it is obtained in France than can be produced by the English method of manufacturing it. Cupric acetate is never employed, I believe, in England,—the much cheaper copper salt, the sulphate, being always employed.

In "Miller's Chemistry" it is stated it "may be obtained by *boiling* solutions of arsenious anhydride and cupric acetate, and adding to the mixture an equal bulk of *cold* water." Why it should be recommended to add *cold water*, I am at a loss to understand.

In Drs. Roscoe and Schorlemmer's large work on "Chemistry," and in the English edition of "Wagner's Handbook of Chemical Technology," edited by Mr. Crookes, the process as described by Dr. Ehrmann in the "Ann. Pharm.," xii., 92, is given. It is thus stated in Wagner's work: "This pigment is prepared by first separately dissolving equal parts by weight of arsenious acid and neutral acetate of copper in boiling water, and next mixing these solutions while boiling. There is immediately formed a flocculent olive-green coloured precipitate of arsenite of copper, while the supernatant liquid contains free acetic acid. After a while the precipitate becomes gradually crystalline, at the same time forming a beautiful green pigment, which is separated from the liquid by filtration, and after washing and carefully drying is ready for use. The mode of preparing this pigment on a large scale was originally devised by M. Braconnot, as follows:—15 kilos. of sulphate of copper are dissolved in the smallest quantity of boiling water, and mixed with a boiling and concentrated solution of arsenite of soda or potassa, so prepared as to contain 20 kilos. of arsenious acid. There is immediately formed a dirty greenish coloured precipitate which is converted into Schweinfurt green by the addition of some 15 litres of concentrated wood-vinegar. This having been done, the precipitate is immediately filtered off and washed."

As I have already stated, the copper salt used in the manufacture of this pigment in England is the sulphate, and it is carried out pretty much according to Braconnot's method as described by Dr. Ehrmann; but anyone would infer, from reading his description of the manufacturing process, that the compound, aceto-arsenite of copper, was formed almost immediately after the addition of the acetic acid, a

higher or lower atmospheric temperature having no effect in hastening or retarding the formation. Furthermore, it is not stated whether the compound forms more readily in an acid or neutral solution, or whether it can or cannot be formed in a neutral one; now both these points are important to notice in describing its manufacture. As regards the former I shall notice it presently, and, as far as my knowledge extends, the pigment will not form when the solution is neutral.

The operation is conducted in the following manner in the factory:—The requisite quantity of sulphate of copper is placed in a large wooden vat, and hot water added to dissolve it; the requisite quantity of arsenic (arsenious anhydride) and carbonate of soda, the latter not in quantity quite sufficient to neutralise the whole of the sulphuric acid set free from the sulphate of copper on the precipitation of the copper as arsenite, are placed in another wooden vessel: water is then added, and the formation of the arsenite of soda and its solution are aided by the introduction of steam into the liquid. When complete solution has been effected the arsenic solution is run off into the vat containing the solution of the sulphate of copper, arsenite of copper being at once precipitated. The necessary quantity of acetic acid is afterwards added. In *warm* weather the formation of the aceto-arsenite soon commences after the addition of the vinegar; but, even in that case, it takes a week or more to have the whole of a big batch of arsenite converted into the aceto-arsenite; and perfect conversion is necessary, as the presence of a very minute quantity of unchanged arsenite lowers very much the price of the emerald pigment, and a by no means large quantity renders the pigment unsaleable, owing to its dirty yellowish green colour. In cold weather a much longer time is required for its complete conversion; even at the end of a fortnight or three weeks there frequently remains sufficient unconverted arsenite to affect seriously the selling price of the colour: when this occurs the manufacturer generally removes these last traces by a most wasteful method, *viz.*, by adding a quantity of free sulphuric acid. The acid of course dissolves the arsenite, but it dissolves in very much larger quantities the aceto-arsenite; and this costly solution is not utilised, but is run into the factory sewer.

By my method of manufacturing it, it can be produced in winter as well as in summer in one or two hours, and the quantity of free acid required for its formation is reduced to the lowest amount. I proceed as follows:—After having

dissolved in hot water the requisite quantity of cupric sulphate, I decompose one-fourth of this salt by adding just sufficient of a solution of carbonate of soda to precipitate the copper, in that quantity of the sulphate, as carbonate. I then add just sufficient acetic acid to convert the carbonate into acetate. I have now got in solution—

$$3CuSO_4 + Cu(C_2H_3O_2)_2,$$

and I have to transform it into—

$$3CuAs_2O_4 + Cu(C_2H_3O_2)_2.$$

It is at once seen that I have got the requisite quantity of acetate formed. I next dissolve the requisite quantity of arsenious anhydride in an amount of carbonate of soda *rather less* than is sufficient to neutralise the acid in the remaining cupric sulphate, and I then bring the solution to or near the boiling-point by introducing steam into it: the arsenic is dissolved not in the same vessel as the copper salt, but in a separate one. When the arsenic solution is fully heated a small current of it is allowed to flow into the vat containing the copper salts, and brisk stirring is kept up in the vat. The emerald-green is at once formed; but if there should be the slightest formation of any arsenite, the flow of the arsenic solution is at once stopped until every trace of the arsenite has been converted: the arsenic solution is then allowed to flow in again, with the same precautions as before: in this way a large batch of emerald-green can be formed in one or two hours, without containing the slightest trace of the arsenite. I keep the arsenic solution near the boiling-point during the whole of the time it is flowing into the other vessel. By varying the proportions of water I could either make it coarse or fine, as I wished, which is an important matter to have complete control over in its manufacture.

Two points of interest occurred to me during the time I was occupied with the research, which I had not time to complete: one was whether the aceto-arsenite can be formed, adopting the old method for its formation, if there is more than a certain quantity of water; from some experiments I made in this direction I was inclined to the opinion it could not. I have already stated that emerald-green is soluble to a certain extent in acids, and that it is formed in a more or less acid solution; consequently a varying amount of the pigment is always lost by being dissolved in the supernatant

liquid. To prevent to a certain extent this loss I precipitated the copper from it as arsenite; but I was not successful in the few experiments I had time to make on this part of the subject of re-converting the copper arsenite thus obtained into the aceto-arsenite by the addition of acetic acid.

V. SIGNIFICANT NOMENCLATURE.

By Wm. John Grey, F.C.S.

MR. F. FERNSEED, as a representative of the non-significant side of scientific nomenclature, has made a very able attack upon the opposite school in the "Journal of Science" for April last, and I wish, as one of those who are of opinion that a scientific name should be made as significant as is conveniently practicable, to offer a few observations by way of reply. Significant names are systematic names, and therefore scientific names, for the object of Science is to systematise knowledge as well as to acquire it; indeed the mere accumulation of facts is scarcely to be dignified with the title Science.

Sciences have advanced rapidly or slowly, very much in proportion to the amount of system which could be applied to them. As examples of this, the cases of Astronomy and Meteorology may be cited: in the first great progress has been made, mainly on account of the system which the law of gravitation enabled to be constructed out of the observed facts; in the second case we have but little more than a chaos of observations which it has not yet been found possible to systematise.

The science of Chemistry occupies a kind of mean position between the perfect system in Astronomy and the almost complete lack of system in Meteorology. Much has been done in the way of systematising Chemistry, but probably very much more remains to be accomplished, and chemists are yet waiting for the man who will do for their science what Newton did for Astronomy and Darwin for Natural History. No significant nomenclature is possible unless the science in which it is used has become more or less systematised, and hence significant names are an indication of at least some progress. It is of course easy to object to

significant names on account of their length, and an objection on this ground applies especially to the names used in Organic Chemistry, many of which are certainly somewhat cumbersome. Dinitromonobromobenzene is a long word, and it is not very pretty or euphonious, but it clearly indicates what the compound is (isomers excepted); and the gain of such clear indication is enormous. The great beauty and utility of these long names in Organic Chemistry is that they distinctly state to a chemist, who may never have heard of the compound, exactly what it is. There may or may not be such a substance existing as amylethylmethylphenylammonium hydroxide: I never read of it, but if I met with the above name I would have no difficulty in writing the formula, and I would also have a general idea as to its properties and probable reactions. It is possible to make fun of monstrosities like the above, and occasionally a feeble jokelet appears in the comic papers based on the long names in Organic Chemistry; but scientific nomenclature is meant for scientific men, who need not care if outsiders try to veil their ignorance by endeavouring to raise a laugh. One objection to significant names in this science is that a compound not unfrequently has two or even more names, according to the view taken of it. Thus C_6H_5Cl may either be looked upon as a chloride of the positive radical phenyl, or as a substituted derivative of benzene; in the one case it is termed phenyl chloride, in the other monochlorbenzene. Similarly the compound $C_6H_5NH_2$ may be called phenylamine or amidobenzene, according as it is regarded as derived from ammonia by replacing an atom of hydrogen by phenyl, or from benzene by replacing a hydrogen atom by amidogen. These double names do not cause any real inconvenience to chemists, but they doubtless perplex learners.

Occasionally theories change,—that is, the method of classification alters,—and this necessitates some variation in significant names: this variation causes, or at any rate tends to cause, confusion, and its existence—or at least the liability to its existence—is rightly put forward by Mr. Fernseed as an argument against significant names. There is certainly some force in this contention, but it scarcely outweighs the general utility of significant names, and the instance quoted as to a change in a significant name rendered necessary by a change in theory is not very apropos. The compound $Na_2S_2O_3$ had been in the first instance assigned an erroneous appellation. Sodium sulphite is

$SONao_2$, and the prefix "hypo" to the name of an acid indicates that the acid with the prefix contains less oxygen than the normal acid. In the case before us, however, the prefix was erroneously used to denote not a compound containing less oxygen, but one having an extra atom of sulphur. The salt $Na_2S_2O_3$ was thus incorrectly named at starting; and when Schützenberger discovered the compound $SNao_2$, which was the real hyposulphite, a difficulty certainly arose, —not in consequence of a change in theory necessitating a change in a significant name, but because an incorrect name had been assigned to $Na_2S_2O_3$, by Chaussier, at the outset. Clearly sulphosulphate or thiosulphate is the correct name, and had the salt been thus designated at first there would not have been any difficulty caused by the discovery of the real hyposulphite.

I am not prepared to assert that no cases have arisen of a change in theory causing confusion in nomenclature, by rendering imperative the alteration of a significant name, but certainly the instance mentioned is not such a case.

The utility of significant names is obvious, and it would be a great convenience (to take Mr. Fernseed's illustration) if instead of calling a man John Smith it were possible to name him in such a manner as to indicate his mental, moral, and physical capacity and bias. We would then, on being introduced to any one, know how far his acquaintance was desirable. It is not possible at present to name persons in this manner, and so, when introduced to Mr. John Smith, we have to find out such of the above-mentioned particulars as we desire to know in the best way we can. This would never do in Science; it would be fatal to further progress if there were a few hundred "John Smiths" in Organic Chemistry, and we were compelled to find out by research of which one we had got hold. Thus, then, I contend that in ordinary life significant names would be very useful, and that the fact that we manage to do without them is no argument against their use when such use is possible.

Supposing that each chemist who invents a new compound (and there are scores of men who invent scores a-piece) were to name it anyhow, the confusion would put an end to all further research. A chemist works, for example, at the substitution derivatives of a hydrocarbon; there may be scores of such derivatives, including isomers; and what would be the result were he to give them "fancy" names? We might get several hundred organic compounds called "Cinderalla," for instance.

At present significant names in Organic Chemistry, long

and awkward as many of them are, so far from being a "crying evil," are absolutely essential to progress. An alternative may possibly be found in a scheme of classification similar to that outlined in Prof. Frankland's "Lecture Notes." Organic compounds are divided into thirteen classes, and the classes are divided into series, the members of a series differing from each other by the increment CH_2. For example, butyric acid is the fourth member of the first series of Class 7, and might be designated as C. VII., S. 1, No. 4. There would, however, have to be much sub-classification to include the majority of chemical compounds, and some method would have to be devised for indicating substitution derivatives and the host of isomers resulting therefrom. Still a system similar to the above seems at present the only alternative to significant names of terrible length. Probably, however, some day the science of Chemistry will bend her fair neck to the yoke of Mathematics, and then the symbols of Algebra and of the Calculus will replace "significant names."

VI. THOUGHTS ON IMITATION.

By J. W. SLATER.

"MIMETISM" or mimicry,—the truth which Bates and Belt discovered in their tropical wanderings, and which other writers have since been hammering out into the very thinnest of gold leaf for the edification of their readers? No: I wish to say a few words on intentional, conscious imitation by one animal of the gestures, movements, and sounds of other creatures. It is, perhaps, strange that a phenomenon of so daily occurrence should still be misunderstood, but here, as elsewhere, familiarity breeds contempt. In short, "imitation" is a word with which men juggle almost as cleverly as they do with "instinct." A monkey is seen to unlock a door, or to put on a pair of spectacles; a parrot, seeing someone in company take out his handkerchief, enquires "Have you got a cold?"

Immediately *Homo sapiens* dismisses the whole matter with a curt, "Ah, only imitation." Here *Homo sapiens* doubtless forgets that his own vaunted faculty of speech—according to Professor Max Müller and others the Rubicon between man and "brute"—is merely, as we shall find below, an outcome of this same propensity.

But do we ever ask ourselves what the power of imitation involves? Let us take the common case of a parrot imitating human speech: what faculties must the bird possess and exercise before such imitation is possible? In the first place there must be close and accurate observation. The bird must distinguish with great nicety the sounds which she hears, including, not merely the effect of the different letters, but all the peculiarities of the speaker's voice, as loud or soft, high or low, gruff or smooth, with all the minutiæ of accent and pronunciation in which one speaker differs from another. So close is the reproduction that a parrot brought up in "society" may be at once distinguished from its fellow which has received a tavern education, even when uttering the very same words.

I need scarcely say that we have here full proof, not alone of close and accurate observation, but of attention. The bird evidently concentrates its mind upon the sounds heard.

Another faculty which "mere imitation" implies is memory. A parrot or magpie, or other talking bird, when it has once mastered a word or phrase, will retain it for years. We must even admit in these birds, as in ourselves, the existence of *latent memory*. A parrot may cease to utter some speech, and judging from analogy may have forgotten it. Suddenly, without any outward cause, or at least without again hearing the words, they return to her mind, and are again uttered. Of this I have had a very decisive instance: My parrot, a fresh arrival from the Gold Coast, and only beginning her education, heard some words uttered in the Norsk language by a little grandson of mine who was over on a visit from Norway. She caught up the words, repeated them for a few days, and then apparently forgot them. Suddenly, some fourteen months afterwards, she surprised me by bringing out the very same Norsk words, which she had certainly never heard in the meantime.

But verbal imitation implies something much more than verbal memory. The words uttered are connected with objects and events seen or taking place at the time when the words were first heard. This is proved by the familiar fact that parrots, magpies, ravens, &c., learn to connect names

with persons, things, and actions. It is nothing unusual for such birds to call the members of the family correctly by name, to exclaim "good morning" when anyone first enters the room in the morning, to call out "good-bye" if anyone is leaving. My parrot above mentioned has more than once on seeing water drawn from a tap, cried out: "Water, water! Polly wants!" Another, belonging to a late medical friend of mine, if she saw any kind of food being consumed, especially fruit, always said: "Give Polly a bit if you please!" Another parrot, an ill-tempered, noisy bird, the property of an extensive taxidermist, when she has been screeching, generally finishes by saying: "You devil, what is this row for?" Thus we have full proof that "mere imitation" implies not only a recollection of words, *per se*, but their remembrance in connection with all the attendant circumstances. So that henceforth the sight of a person or object, or the occurrence of an action suggests to a parrot the words. Here, therefore, in addition to memory there is association. It need scarcely be said that all the powers of observing, retaining, and associating sounds possessed by parrots and certain other birds would go for nothing if they had not in addition well developed vocal organs, and if, further, their nerve centres were not highly specialised.

The higher birds thus learn the use of language in the same manner, though not to the same degree, as do we in our childhood.

It is remarkable how completely metaphysicians and philologians forget the imitative origin of language in man. Some of them incline to the opinion that language is not a faculty which has been gradually developed, but a divinely implanted power. Such thinkers might do well to consider that children who have been brought up by wild animals, *e.g.*, among Pariah dogs in India, are mute; that not only those who have the misfortune to be born deaf are also, but that children who have at different ages become deaf from disease lose the power of speech. Hartmann, in his work "Deaf-Mutism," gives, if I remember aright, an instance of this occurring even as late as the tenth year of life. Hence language in man, as in the parrot, is simply due to imitation, and where such imitation is excluded by deafness, or by the absence of human society, he, too, is, according to a common cant phrase, one of the "dumb animals," How the anti-evolutionists can justify their theory of the origin of speech in the face of these facts I do not see.

The imitation of the actions and gestures of man, or of

other creatures, is more common among mammals than birds, from structural reasons. To what an extent it occurs among the monkey tribe is well known. In the cats, or at least in the one species of that group which ordinarily comes under human observation, it is not unknown, though rare. The same may be said as regards dogs and weasels. But lower down in the mammalian series it appears unknown. We find no instances of imitation among the marsupials, the edentates, and probably the ruminants. We must, however, among the latter exclude that crude phase of imitation which is witnessed in sheep, where, if one runs, all the rest run, and if one jumps, all jump, even though the object to be overleapt has been removed. But we never see a sheep attempting to imitate the conduct of a man, a dog, or a cat. The ruminants are not wanting in curiosity, which in weak species is largely mixed with fear and suspicion, and in stronger ones with hostility. But it is in all cases undiscriminating.

The imitative actions of mammalia of course imply, other things being equal, the same faculties as the imitative sounds or cries of birds. We may therefore regard it as, to say the least, discreditable rashness, when metaphysicans and *litterateurs* pronounce such actions of birds and mammals "merely imitative" in the hope of thereby denying the intelligence thus manifested. For, in addition and prior to the desire to imitate, there must exist, as we have seen, certain intellectual faculties, without which that impulse, even if it existed, must be abortive.

But wherefore should any animal seek to imitate the actions of another animal whether of its own or a different species? What advantage can it derive from such imitation? At first sight it might seem none whatever, and we might perhaps feel puzzled how to account for the origin of the propensity for imitation, whether we regard it as an impulse originally implanted in certain species, or as having been developed under the action of the struggle for existence.

But we should in so doing fall into a grave error. It has been found that the tiger imitates the peculiar whistling cry with which the large Sambur deer call one another. The imitation is said to be so close that only an experienced ear can distinguish any difference. The leopard of India, in like manner, counterfeits the cry of a smaller species of deer. Here we may carry our considerations of what is involved in imitation at least one step further. The tiger has not only observed closely and accurately the cry of the deer,—not

only fixed the particulars in his memory and associated the sound with meeting of deer after it has been uttered,—he, in addition, sees that there is here a certain advantage to be derived, and accordingly reproduces the whistle with great fidelity. Further observation will doubtless disclose many more instances of purposive imitation in the conduct of animals, as distinguished from involuntary mimetism. But most of the animals which possess the tendency to imitation in a high degree, such as the monkeys and parrots, are not carnivorous, and therefore cannot have any such motive as the tiger or the leopard above mentioned.

We must therefore inquire what properties the imitative animals have in common? They are all, probably, decidedly sociable; all occupy an eminent rank in their respective groups, and all, from man downwards, have a highly developed brain and nervous system. They all require a language as a means of communicating to each other their wants, their fears, and, to a certain extent, their ideas. But were they not imitative they evidently could never have possessed languages. The sounds made by each would not have been repeated by others, and would thus never have become the common inheritance of the species.

But there is a further consideration: the higher the development of any animal, species, or individual, the less exclusively are its actions to be understood on utilitarian principles. If we analyse the activity of man, keeping our eye especially on the highest races, and the highest members of such races, we find that no small proportion of such activity is directed to objects which have no direct connection with the preservation either of the individual or of the species. The savage, when not ministering to the direct wants, nutritive or sexual, of the passing moment, does very little indeed. The savant and the artist seek to minimise the share of their energies employed in self-preservation. Viewing this wide range within the boundaries of one species, commonly so called, is it too much to suspect that, even in certain of the lower animals, a portion of vital energy and of time may be consumed in pursuits which might be dispensed with? The caged parrot, indeed, utilises the human language which it learns by calling attention to its wants. But, as far as I can judge, it derives pleasure from imitating the cries of cats, dogs, poultry, the sounds of musical instruments, and the creaking of machinery. In like manner the monkey feels

satisfaction in attempting any performance which it has not yet seen. Both these animals, to me at least, seem to have a reserve fund not merely of energy, but of intelligence, which, as in the case of the savage, is not ordinarily called upon in the normal business of their lives. How this intelligence can have been developed is to me a riddle, alike in the savage and in the ape.

It has been often remarked that, in man, gestures, actions, feelings, conduct of the most varied kind, is, in vulgar language, *catching;* that hysteria will spread through an establishment for young ladies or a nunnery as rapidly as can scarlet fever. May we not suppose that the tendency of monkeys and parrots to imitate the actions and sounds which they see and hear is a part of kindred origin?

VII. OBSERVATIONS OF BRIGHT LINES IN THE SPECTRA OF FIXED STARS.

THE spectra of certain fixed stars have been made the subject of careful and frequent observations, and the results obtained have led astronomers and physicists to some interesting conclusions. They have inferred, for instance, a general identity of the elementary chemical composition of the universe, or at least of all of the stars which they have been able to examine. They have also classified the stars according to their apparent age. First, namely, come those which give out a bluish white light, and are therefore still in the most intense state of ignition. Secondly, those which, like our Sun, give out a more yellowish white light, and which have probably lost some of their original heat. Lastly comes a class whose light is reddish, and which may therefore be supposed, by analogy with terrestrial fires, to have cooled down considerably.

But later observations, especially those of H. Eugen von Gothard and H. von Konkolly, as described in the "Astronomische Nachrichten" and in the "Naturforscher," point to frequent changes in the physical condition of certain

stars, not obeying, apparently, any regular period, nor depending on a mere increase or decrease of temperature.

An unusual appearance of bright lines in the spectrum of γ Cassiopeiæ and β Lyræ seems first to have been noticed by the late Roman astronomer Secchi. Subsequently Mr. Huggins identified in γ Cassiopeiæ the bright lines H_a, H_β, and D_3, whilst in 1872 Herr Vogel could see and measure only the bright line H_β. He further suspected a bright line in the yellow (D_3), and found only a few dark lines in the red. In the spectrum of β Lyræ the same physicist measured, in 1871, three bright lines identical with H_a, H_β, and D_3. Subsequently these lines became so faint that they could be perceived only by the aid of especial artifices. Even in different successive evenings they appeared of different intensities, which could not be brought in connection with the conditions of the atmosphere.

Subsequently these bright lines seem to have disappeared entirely, for though they were repeatedly sought for at the Observatory of O'Gyalla they were not seen from 1874 until 1882. Herr Eugen von Gothard frequently examined these interesting stars spectroscopically since the opening of his Observatory, in the autumn of 1881, but without effect. In 1882, on July 24th and August 7th, he could distinguish in γ Cassiopeiæ merely a dark band in the red. The spectrum of β Lyræ was about this time continuous without lines or bands. On September 5th, however, the dark lines H_a, H_β, and H_γ were observed.

The two stars in question seemed, according to these phenomena, to belong to the class of temporary stars which blaze up with great intensity and then fade down to a greater or lesser extent. But further observations did not support this supposition. On August 13th, 1883, Herr von Gothard saw in the spectrum of γ Cassiopeiæ the red line H_a flashing up along with the dark lines formerly observed; but on account of the bad state of the atmosphere and of moonlight nothing could be determined with certainty. But on August 20th not only the line H_a, but the lines H_β and D_3 were distinctly recognised: the bright lines could even be measured, and gave the wave-lengths for H_a 654·7, for D_3 586·7, and for H_β 484·9, whilst for the middle of the dark band λ was found = 633·0. These lines were observed also August 22nd, 24th, 25th, and 26th. H_a and H_β came out well, D_3 not so well and less frequently. On August 26th Herr von Konkolly, who took part in the observations, succeeded in recognising the violet line H_γ:

On September 1st the lines H_α and H_β were very intense in spite of the moist and disturbed state of the atmosphere; H_γ was also distinguished. D_3 was no longer visible, but the dark sodium lines were seen. The latter, however, could not be measured, and subsequently they disappeared entirely like D_3. The lines H_α and H_β were observed at the end of September and in November, even in the most unfavourable circumstances. H_γ appeared also several times when the air was better, as well as the dark lines of the *b* group.

The measurements which Herr von Gothard succeeded in executing on November 29th showed a displacement of the bright lines towards the red extremity of the spectrum. The determinations were therefore repeated on December 21st, with a very careful comparison with a Geissler tube filled with hydrogen. The comparisons were limited to the line H_β, and gave for the wave-length of the line in the spectrum of γ Cassiopeiæ the value 486·5, and in that of the Geissler tube the value 485·9; consequently a displacement of 0·6 millionth of a millimetre towards the red end of the spectrum.

In the spectrum of β Lyræ, also, the bright lines which had vanished up to 1882 reappeared in August last year (1883). The lines H_α and H_β were very distinct on August 26th, but they could not be distinguisned on September 28th, possibly on account of the great perturbation of the air. The next evening (September 29th) Herr von Gothard was surprised on witnessing the following phenomena:—D_3 was brilliantly beautiful, the most intense of the three lines; H_β was very fine; but H_α was very faint, scarcely visible. Occasionally a dark band was perceptible, rather more strongly refractive than H_α. In proportion to the general faintness of the spectrum, the bright lines were much more intense than in γ Cassiopeiæ.

On October 18th the bright lines D_3 and H_β and the dark band were very distinct, notwithstanding the badness of the weather and the strong moonlight. This was the more remarkable as in the previous year the search for these lines had been unsuccessful, even in the most favourable weather. On October 26th, with a large new spectroscope, the bright lines D_3 and H_β and the dark sodium lines were still very distinct.

On November 21st occurred another unexpected change. Herr von Gothard could find only the bright line H_β, and this with great difficulty; D_3 and H_α were vanished. On

November 23rd D_3 and H_α were again visible, though faintly, whilst H_β was tolerably distinct.

On November 28th, though the atmosphere was very much perturbed and the constellation low in the heavens, H_β and H_α were easily perceived, and even H_γ was often suspected, whilst, in spite of all attempts, D_3 remained invisible.

It need scarcely be said that the key to these anomalies can be found only by a multiplication of observations in the most favourable localities.

ANALYSES OF BOOKS.

The Law of Sex: being an Exposition of the Natural Law by which the Sex of Offspring is controlled in Man and the Lower Animals, and giving the Solution of various Social Problems, with Forty Illustrative Portraits. By G. B. STARKWEATHER, F.R.G.S. London: J. and A. Churchill.

THE author of this work propounds a law, which if capable satisfactory demonstration is of very great biological value. Not confining himself to pure science, he has also an eye to practical applications, and believes that among the results brought about by the publication of his work will be "the possible assimilation of alien and lower races, and the avoidance of a lamentable redundancy of women in old settled countries."

In forming an estimate of the work—or rather of the theory which it expounds—we have to deal with the double question: Is the proposed law valid? and, admitting such validity, will its practical recognition lead to the results which Mr. Starkweather hopes?

The primary problem is this: Given a pregnant female animal, what will be the sex of her offspring?

Before stating his own reply the author reviews certain existing opinions. Thus we are told by some that the parent which at the moment of conception is the more impassioned impresses its sex on the offspring. The older theories of sex, are rightly enough, described as "chiefly ovularian or spermatic, with various theories of development superadded, such as those of epigenesis, metamorphosis, and syngenesis." A vague popular notion is that the will or the imagination of the mother determines sex. Dr. Naphreys puts forward a hypothesis which has a more scientific appearance. He maintains that every ovum passes through two distinct phases of development. If it is fecundated during the former stage the offspring will be female, but if during the latter male. This view, however, is not supported by recent observations. The author further asks, acutely enough, "How would this theory apply to twins, or to multiparous animals where there may be representatives of each sex produced at a birth?" We must here, however, quote a passage as indicative of his habits of thought:—"Would it not be positive confusion if Nature has, as Dr. Hough maintains, given but six days per month in which females can be conceived—and if in the last two or three of these they must be insufferable viragoes; and to the males has allotted as many more days—on

the first three of which shall be produced specimens as much too effeminate as the preceding ones were too masculine? Is it possible that Nature is thus constrained to inflict misery upon so large a portion of the human family?" Alas! if the avoidance of misery were a ruling principle in Nature, should we see sickly or debilitated animals still capable of reproduction, and thus perpetuating disease and suffering? We quote the above passage, however, as an instance of the author's tendency to argue from moral considerations when discussing physical laws.

Another theory, the so-called "Alternate," is that Nature makes all human *ova* either male or female, and supplies the former one month and the latter the next. This supposition is again refuted by the case of twins of different sexes.

The theory commonly ascribed to Hippocrates is that the parent physically the more vigorous at the time of conception gives his or her sex to the offspring. As Cuvier words it:—"To obtain an excess of female offspring the father should be young and ill-fed, and the mother should be of mature years and highly fed." Certain experiments performed with flocks of sheep seemed to support this hypothesis. But it was found that eighteen consumptive mothers (who by-the-bye should not have been married at all) gave birth to eighty-seven children. Upon the basis of vigour most of these should certainly be boys. But no; seventy-four were girls and only thirteen boys—one seventh.

Before proceeding to expound his own theory Mr. Starkweather discusses the comparative rank of the sexes. To his conclusion that both are essentially equal, though not identical, we cannot object. But what must we think when, speaking of those who maintain female superiority, he writes, without comment,—"The general tenour of their arguments is that woman is a later creation (!) and therefore of a higher order"? Another chapter, on "Heredity and Sterility," contains, along with much that is suggestive and worth a careful consideration, the following passage, strangely out of place in a scientific treatise:—"It might make mothers blush if they knew how many a tale is written so plainly on the faces of their children that the whole world may read what they had fondly hoped would ever remain a profound secret. Where you find a family of children strongly resembling their father, it is unmistakable evidence that he was almost constantly in the mother's mind during the period of gestation."

These preliminary matters being disposed of, we come to the author's law, to wit:—"*That sex is determined by what I shall designate as the superior parent; also that the superior parent produces the opposite sex.*" Of course we naturally ask in what sense is the term "superior" here used, and how is superiority to be recognised? The answer is by no means so clear to the reader as it doubtless may seem to Mr. Starkweather himself. He admits that there are numerous factors to be taken into account, such as temperament, activity, energy, will, intellect,

features, colour, physique, health, nutrition, &c. The term superiority "must be understood to include all these . . . . and it does not follow that this kind of superiority must in all cases coincide with superiority in the general sense of the term—by which we imply superior mental and moral qualities." We have, then, the difficult task of comparing two values, M and F, each made up of ten or more variables, for most of which we have no definite standard. Hence, in bringing Mr. Starkweather's theory to the test of observation, there is room for doubt and even misinterpretation. This we much regret, since it stands in the way of that full examination and fair decision to which it is entitled.

It may, however, be suggested, that the author has refuted himself. If we understand him aright he considers that the sex of the offspring must depend on the relative state of the parents at the moment of conception. He urges that "the theory advocated in this work is applicable to the lower organisms equally with man. . . . . If it could not be thus applied it would be worthless as a complete theory." Yet on page 26 we find him writing—"It has recently been discovered, by repeated experiments, that the sex of butterflies depends upon the surrounding conditions of the larva rather than upon the anatomical structure, as has heretofore been universally supposed. The sex of almost everything else in nature is determined at the time of conception, or *very early in the embryonic state;* and why should these creatures form an exception to the rule? Caterpillars that were fed abundantly for a time before entering the chrysalis state came out female butterflies in the proportion of ten to one, while those which were deprived of food altogether came out with a like predominance of the male sex. M. Gentry confirmed this fact in his experiments with moths." Here, therefore, Mr. Starkweather's view is plainly inapplicable, and, according to his own admission, is hence "worthless as a complete theory"! We should feel disposed to suggest that the author would, for the present, do well to confine himself to the vertebrates.

The attempt to ascertain what "life is like" by a comparison with electricity opens up regions of speculation far too wide for present discussion, even if the state of human knowledge would admit of their useful consideration. The author, speaking of the generative act, says:—"Like other electrical phenomena it is practically *instantaneous:* is this nothing more than a coincidence? Have not these forces a common origin?" It is surely unsafe, on such a slender basis, to identify life, or one of its manifestations, with electricity.

A strange contention is here borrowed from a Dr. J. C. Jackson, of New York, that—"It lies within the power of the individual to modify his physical organisation so that it may be very different from what it has been. . . . . What can thus happen in physical conditions can to an equal extent happen in mental conditions. The dull man can become bright, the excitable man

cool, &c." It may be asked how this agrees with the full admission of the predominant importance of heredity, of the supremacy of nature over nurture, which we find in the beginning of Chapter V.? The author there justly asks whether it was education "that made the contrast between Newton and Boswell? or Henry Kirke White and Edgar Allan Poe?" And if training in youth, when the system is still mobile, is of less importance than blood, can we be seriously asked to believe that the adult man or woman can revolutionise his or her constitution or character?

But supposing that we accept the author's theory as regards man and the vertebrates generally, are the practical applications which he thinks it admits of as important as he supposes? He, in common with Mr. Greg, speaks of the "lamentable excess of women." But this is due not to physiological or moral causes, but to economical conditions. An immense number of men, in this age of mad competition, are shut out from marriage by the simple impossibility of maintaining a wife and family. What is needed is that the supply, both of men and women, should be within the demand, and this can be done only by confining the perpetuation of the species—as in the case of the domestic animals—to the *élite*. The redundancy of women has been greatly fostered by those social *bacilli*—if we may use the expression—who are striving to sow enmity between the two sexes, and to "undifferentiate" our species by setting women to do men's work. For every woman who edges herself into a profession it is safe to say that at least one other woman is doomed to join the "redundant" class whose existence is lamented. We are, therefore, glad to find that a needed rebuke is here administered to a lady who has made herself prominent both in promoting antagonism between man and woman and in throwing obstacles in the path of biological research.

Taken as a whole the work literally teems with interesting matter, and there are numbers of passages which would be well worthy of attentive discussion did space allow.

Sleep-Walking and Hypnotism. By D. Hack Tuke, M.D., LL.D. London: J. and A. Churchill.

The subject of sleep-walking is not unnaturally attracting no small share of attention. Connected as it is with epilepsy, with insanity, and with what is known sometimes as Mesmerism and sometimes as Hypnotism, its study may aid in solving certain of the most interesting problems, both physiological and psychological. We are therefore glad to find that so competent an

authority as Dr. Tuke has undertaken to consider sleep-walking or somnambulism as parallel with hypnotism. He remarks, in the very outset of his treatise, that "on the vexed question of animal magnetism the bearing of natural somnambulism is most important, as the condition and acts of the sleep-walker cannot be attributed to a magnetic fluid passing from an operator to the subject.

It need scarcely be said that Dr. Tuke does not, with Casper, refer the majority of cases of sleep-walking to credulity or imposture. He admits, of course, that it may be simulated, without on that account denying genuine phenomena. Its connection with chorea, with hysteria, epilepsy, and even insanity, is recognised, though the author does not feel free to remark, with Dr. Echeverria, that "somnambulism generally forebodes, when it does not betray, insanity." As a matter of course, in all the above-mentioned phenomena, normal will is for the time being lost. But it is difficult, if at all possible, to give an account of what takes place in sleep-walking without using language applicable to mental aberration. From instances here mentioned it is plain that the sleep-walker may be no less dangerous to himself and others than the lunatic. Not to speak of the frequent attempts of sleep-walkers to rush out at the windows of upper rooms, &c., a case is mentioned of a man named Fraser who killed his child whilst in a fit of somnambulism, and on trial was found not insane, but irresponsible. The author holds that this man, if not insane, was as dangerous as a madman, and thinks that "more stringent means ought to have been taken to guard against his doing anyone an injury,"—an opinion in which most of his readers will coincide.

Some decidedly conflicting views are given on the responsibility of sleep-walkers. Thus Foderé holds that a man who commits a bad action during sleep is not wholly inexcusable, since in accordance with most observations he is only executing the plans which occupied his mind when awake. On the other hand, Prof. Bell contends that in dreams the moral sense is always asleep. The question is of the more importance since certain injudicious thinkers urge that the drunkard should be held irresponsible for his actions,—a fearful mistake.

The state of the senses in somnambulism is a point of much interest. The power of sight in the dark seems very acute; the pupil is dilated, and the sleep-walker thus sees objects with a degree of light which in a normal state appears darkness. It is maintained by some authorities, *e.g.*, Dr. Guy ("The Factors of the Unsound Mind"), that things are even seen by the sleep-walker "when cards or sheets of paper are interposed between the eye and the object to which it is directed." Our author takes a different view. He writes:—"What happens is apparently due to the muscular and tactile senses, and in some instances, perhaps, to the subject retaining in his mind a vivid representa-

tion, a mental image, of the writing which he had previously made. It is true that a somnambulist may write well though a sheet of pasteboard is interposed between his eyes and the writing-paper. If he has not crossed a *t*, nor dotted an *i*, and is requested to supply the omission, he may do so with great precision. But if the paper be shifted, his corrections are no longer in their right places on the paper, but wrong to the extent to which the paper has been moved."

A certain lady, named here Madame X, whose case was published in 1860 by M. Mesnet, wrote letters accurately in a room so dark that her physician could not distinguish the objects in it. "That she depended, however, upon her sight was shown by the fact that when an opaque body was placed between her eyes and the paper she stopped writing, and was much disturbed."

The sense of hearing is in some cases good, but in others is totally suspended. Similarly with smell, though one of the author's correspondents often in his attacks dreams of an escape of gas, and in his sleep searches for the gas-pipe, though there is no gas laid on in the house. There is often insensibility to pain, accompanied with an extreme delicacy of touch and an abnormal acuteness of the muscular sense.

Epidemic somnambulism is an exceedingly curious phenomenon, and not very rare.

Since at the present day "Mesmerism" has penetrated even to the Royal Institution, where a crocodile has been successfully operated upon, this work will prove exceedingly useful to all who are desirous of studying that intricate subject from every possible point of view.

A Treatise on Earthy and other Minerals, and Mining. By D. C. Davies, F.G.S. London: Crosby Lockwood and Co.

This volume is a practical handbook of those minerals which are in common life described as non-metallic. Thus we have here the "ores," as they are now called, of sulphur and of phosphorus, carbon and its compounds, silica, borax, and their allies.

Others of the minerals here described are in reality metallic, but the metals which they contain are not often used in the metallic state. Thus everyone now knows that barium, calcium, &c., are metals, but in the metallic state they are merely laboratory curiosities. Concerning sodium and aluminium doubts may be raised. The time is probably not distant when the latter, at least, may play a part almost as important in the free or metallic condition as it does in its salts. Such at least will be the opinion of all who have seen the beautiful alloys manufac-

tured by the Crown Metal Company, and considered the manifold applications of which they are capable.

Mr. Davies has evidently taken great pains in the compilation of this work, and the information given as to the occurrence, the properties, and the uses of the various minerals named, is, with very rare exceptions, absolutely accurate.

The account given of the phosphates, now so extensively used in the manufacture of chemical manures, is almost important and elaborate enough to form a distinct work.

We do not find any mention of the occurrence of vanadium in the iron-slags of Creusot, nor of its very important application in developing aniline-blacks in calico-printing. Bauxite is mentioned merely as a source of metallic aluminium, whilst its chief use at present is doubtless in the manufacture of sulphate of alumina and alum. In England and Scotland alum is rarely now produced from the alum-shales, as, though these contain a considerable quantity of sulphate of alumina ready formed, the cost of extracting it and freeing it from iron is such that china-clay and bauxite are preferred as the raw materials.

All persons interested in mining, quarrying, and the utilisation of mineral products will find this book an indispensable guide.

The Atheistic Platform. VIII. (Fortnightly.) "Is Darwinism Atheistic?" By CHARLES COCKBILL CATTELL, Author of "A Search for the First Man," &c. London: Freethought Publishing Company.

THE circumstance that Mr. Cattell is the Secretary of the Darwin Institute, Birmingham, combined with the plea of precedents (the fact that now and then this Journal does penetrate into subjects having *contact with* rather than *constituting* "science"), must furnish our excuse for drawing attention here to a page and a-half of English print into which is condensed more intellectual or moral obliquity than perhaps any other Darwinian applauder has yet contrived to compress into the same compass.

Mr. Cattell's aim is to deprive of force "a few phrases [which] are frequently quoted to prove" that Darwinism requires us to "speak of matter *endowed* with life, *endowed* with intelligence, &c.," rather than to "speak of living matter." This is done by collating the quotations with italic emphasis, as below, as to all organisms being "descended from some *one* primordial form," and as to "The Creator [having] originally breathed life into a few forms, *perhaps four or five*." These "theological phrases" are "popular modes of expression."

Mr. Cattell then insists that Mr. Darwin "placed beyond all dispute" the falsity of the inference "that the use of the word Creator implies creation"; so popularity of mode of expression will scarcely explain the whole of Mr. Darwin's teleology.

Mr. Cattell now has recourse to a third means of invalidating these awkward popular modes of expression: they "must be judged by his later utterances"; and "with regard to organisms being the work of a creator, his later utterances in the 'Descent of Man' (p. 61) are very clear." But *what organisms?* "Species" *as such*—"separate creations"; in no instance the "elementary bit of moss," as we lately heard a lecturer on "Darwinism according to Darwin" (an applauder) word it. Mr. Cattell thinks otherwise. He thinks that Mr. Darwin "gives ample explanation of his use of current theological phrases" when affirming that he "was not, however, able to *annul* the influence of my *former belief*, then almost universal, that each species had been *purposely created*"; the inference being that Mr. Darwin is attempting to surreptitiously withdraw the "theological phrases" from the "Origin of Species." Mr. Cattell having specified the page, let the reader run and read—and blush. But *if* the popular "modes of expression" *were merely* the residue of an earlier Cuvierism, as we believe Prof. Haeckel would say, why do we find in almost identical language in the edition of the "Descent of Man" of 1871 the alleged tacit withdrawal of phrases retained in the "Origin of Species," sixth edition, with additions *and corrections down to* 1872"?

Mr. Cattell considers, further, Mr. Darwin's later utterances: his remarks somewhat assimilating to the nature of an imputation of deceit. He writes:—"With regard to the existence of a creator and ruler of the universe he says, 'This has been answered in the affirmative by some of the highest intellects,' but he does not answer it himself"; and adds in a foot-note—"In conversation with Dr. Aveling he preferred to describe himself as an 'Agnostic,' which means *I don't know*"—the best answer anyone can give in these days when asked what "Agnostic" means. Then, evidently to confirm the view that Mr. Darwin despised superstition, he relates that "He mentions a savage who with justifiable pride stoutly maintained that there was no *devil* in his land." Now unless Mr. Cattell believes that Mr. Darwin's "considerateness for the feelings of others" (as he styles it) would have induced him to wilfully deceive men concerning this or that "ennobling belief" (for the evidences of Mr. Darwin's theism are—for those who believe he entertained any respect for truthfulness—not confined to one quotation amongst either his earlier or later utterances, but are legion), surely such assimilation of an imputation of deceit is unwise. If Mr. Darwin be now experiencing that immortality which in the "Descent of Man" he seemed to regard as axiomatically established (referring his readers in a foot-note to a work by a gentleman who wrote

a Catechism of the Gospels the year the "Origin of Species" was published, and who, when the "Descent of Man" appeared was Pastor of St. Thomas's Square Chapel, Hackney; but who has—the day this review is sent to the Editor—been elected Member for Leicester), his prayers will include "Save me from my friends!"

Mr. Cattell remarks upon Mr. Darwin's "freedom from dogmatism," and tells us that "He traces the objections to his theory to the 'arrogance of our forefathers, which made them declare that they were descended from demi-gods,'"—a sentence differently quoted by Dr. St. George Mivart on more than one occasion.

Corpulence, and its Treatment on Physiological Principles. By Dr. W. Ebstein. Translated from the Sixth German Edition by Prof. A. H. Keane, B.A. London: H. Grevel.

We have here a work differing widely from the well-known treatise of Banting. Prof. Ebstein investigates physiologically the causes, the conditions, and the collateral effects of that state of body known as corpulence or, in its more extreme stages, as obesity. He shows that the phenomenon in question, though regarded as pathological, and as therefore to be cured, is not marked off by any sharp boundary from the normal condition. In a healthy new-born child the proportion of fat ranges from 9 to 18 per cent of the entire weight. In adults the normal proportion, according to Béclard and Quernay, is 5 per cent for men and 6 for women. We find a notice of the discussion whether the fixed connective tissue cells and the adipose cells are identical, or whether, as Toldt maintains, the fatty tissue of vertebrate animals is a special organ. All observers, however, still agree that every connective tissue cell may under certain conditions be transformed into a fat cell. The liver is the only organ which ever under physiological conditions accumulates fat, and it is the one which most readily passes into the state of fatty degeneration.

In opposition to a very common error Dr. Ebstein maintains that the hurtful influence of corpulency on mental activity has been much over-rated. He shows, however, that as regards health its ill effects are often overlooked. Obesity in its more advanced stages is always accompanied by anæmia, and very frequently by gout and diabetes.

As regards the practical treatment of corpulency the author shows that the remedies often recommended are sometimes injurious, or merely temporary in their action, and sometimes fail altogether. Inaction is generally and rightly supposed to promote corpulence in man, as it aids the fattening process in swine,

oxen, and poultry. The "starvation remedies" are very justly rejected, because while we are starving we lose albumen as well as fat. Excessive bodily exercise is also ineffective. Banting in his confessions tells us that he rowed a heavy boat for a couple of hours daily and gained muscular power, and also a very hearty appetite. As he yielded to its demands he still increased in weight.

There is a condition powerfully opposed to corpulence which Dr. Ebstein does not directly mention, though he refers to its antithesis as promoting fatness in men and in the lower animals. There are few persons advanced in life who will not agree with us that in the first, and even in the second quarters of the present century corpulency was not a perfectly normal feature among Englishmen who had reached their fiftieth year. The "fair round belly"—whether or not "with good capon lined"—was prevalent among country gentlemen, clergymen, publicans, tradesmen, &c. This is now evidently no longer the case. The cause of the change is not an increased amount of bodily exercise nor a more rational diet. It is simply anxiety—work under pressure. But though this is the surest remedy, or rather preventive, for corpulency, it is one which no physician would recommend to his patients. For the author's own system of treatment, which seems judicious, we must refer our readers to the work itself.

In an appendix we find reference to the case of Cornaro, who from his fortieth to his hundred-and-fourth year restricted himself daily to 12 ozs. of bread, yolk of egg, meat, and soup, along with 14 ozs. of liquid. As the author remarks, Cornaro does not state whether he was corpulent or lean at the time when he adopted this strict regimen. It may be added that he makes no mention of his subsequent habits. If his life was spent in inactivity we need not wonder that he found a slender fare beneficial.

Spectrum Colours, Colour Sensations, and After Images. Suggestion for Extending the Dynamical Theory. By G. St. Clair, F.G.S. Birmingham: Herald Press.

This memoir, reprinted from the "Proceedings of the Birmingham Philosophical Society," has been courteously forwarded to us by the author. In it we find some considerations on colour which, in our humble opinion, merit the attention both of the physicist and of the physiologist. The author, after giving a table of the vibration-numbers of the spectrum colours, asks if it is not anomalous that while these colours are a regular series and pass into each other by slow gradation, three of them should deserve to be called primary, and the other four secondary or derived.

He next points out that whilst according to the current theory of colours and colour sensations—that of Young and Helmholtz—we have three colour sensations, yet the latter authority admits that for the present the theory lacks anatomical basis, as no such distinction of fibres can be traced in the retina. He then proposes to take two colours of the spectrum and to add their wave-lengths together, thus obtaining the intermediate length. Thus the mean between yellow and red is almost identical with the wave-length of orange, the intermediate colour. Now it is commonly said that if all the colours of the spectrum are added together they make white light. But if we add together the wave-lengths of all the seven colours and take their mean, we get 0·0000213, which falls between the yellow and the green. This, the author says, is "just where the eye would lead us to expect it. White would therefore appear to be a colour of the spectrum, occupying the medium place, though not always showing plainly, because of the narrowness of its band." The fact that the union of the blue and yellow rays of the spectrum produces white and not green is pronounced by Helmholtz the most striking difference between a mixture of pigments and a mixture of coloured rays. Starting from these facts, Mr. St. Clair disputes the theory of three primary colours. He writes:—"Violet and red should not be regarded as simple colours on the mere ground that they cannot be found by compounding two others. Being at the extremities of the scale neither of them is a mean between two others—no two wave-lengths in the scale, on being added together and divided by two, will yield a value so high as 0·0000256 (red), or so low as 0·0000174 (violet)." Concerning green he quotes Prof. Tyndall, who states that C. E. Wünsch, on mixing yellow with bright blue, obtained a white with a greenish tinge.

The ordinary theory of after-images is not free from difficulties. "If we have been looking at a red patch, and then on turning our eyes away see a patch of blue-green, we are asked to believe that we have fatigued one of the primary colour sensations and made ourselves temporarily blind to red, so that in looking at a white background the affected portion of the retina can only discern the green complementary." Mr. St. Clair, however, brings forward an objection which Mr. S. Hodges also entertains:—"If after we have gazed for thirty seconds at a red patch the retina, or any set of rods there, is so exhausted that it can no longer perceive red rays, it ought to cease to see the red patch when we continue looking at it for more than thirty seconds, which is not the case." Here, however, these writers are both in error. In "matching off" scarlet, magenta, &c., cloths, dyers find it necessary to use great dispatch. If the eyes are fixed on such colours for any length of time fatigue is certainly experienced, and the dyer becomes unable to tell whether he has hit the exact shade required or not.

Another objection to the theory of fatigue is more valid. "It is most difficult to believe that the retina is fatigued by looking at black, since blackness is equivalent to the absence of stimulus, and yet after looking at a black object on a white ground we see an after-image of white on a black ground."

We regret that we cannot enter further into this interesting memoir. Many portions of this require and would repay experimental investigation.

Victorian Year-Book for 1882-3. By H. HEYLYN HAYTER, C.M.G., Government Statist of Victoria. Melbourne: Ferres. London: Robertson.

MUCH of the most interesting matter in this publication, such as the meteorology, the topographical features, &c., has already appeared in the issues for former years. The only novelty is to be found in the records of social and economic phenomena.

Under the head Statistics of Suicide we find a passage worth quoting. Dr. Enrico Morselli, Professor of Psychological Medicine in the University of Turin, after a careful and prolonged inquiry, concludes that suicide is increasing in almost every country; that religion and morals have never reached the root of the calamity; and that the sole preventive, not only against suicide but against madness, would consist in "diminishing the struggle for life amongst men."

The following consideration may serve to moderate the dislike to Chinese immigrants entertained in the colonies. Whilst in 1882 the proportion of persons of English birth arrested for crime was 43·64 per 1000, that of Scotchmen 46·69, and that of Irishmen 83·20, the Chinese were only in the proportion of 18·07 per 1000.

The cultivation of the vine seems to be extending, though the *Phylloxera* made its appearance as far back as 1875, and many vineyards have been in consequence rooted out. The growth of the mulberry and the olive is not increasing, as it might and should. It is unpleasant to see among the imports of such a region "olive and salad oil," "currants and raisins," "jams, jellies, and preserves," and not a few kindred items.

As a very exceptional climatic phenomenon it is recorded that on July 26th, 1882, there occurred a fall of snow at Melbourne, the lowest temperature in the shade being 37° F. and the highest 44° F. No other snowfall had occurred since August 29th and 30th, 1849.

Collins's Advanced Science Series. Mineralogy. By J. H. Collins, F.G.S. Vol. II. Systematic and Descriptive Mineralogy. London and Glasgow: W. Collins, Sons, and Co., Limited.

Of all departments of natural science Mineralogy is probably the least generally popular. It has not shared in the impulse given to Botany and Zoology by the Darwinian reformation, and outside a very limited circle it has neither friends nor enemies. The author, in his Preface, pronounces it to be "little more than a dictionary of minerals," and as such it may be considered accurate and complete.

The classification adopted is essentially that of Dana, Brooke, Miller, and Nicol, somewhat modified by the author. The mineral species are arranged under the heads of Native Elements, Pyritoids, Haloids, Chlorides, Spathoids, Silicates, and Hydrocarbons.

An Appendix gives the meteoric minerals, and certain minerals whose composition is either indefinite or has not been properly ascertained.

The work, like almost every scientific manual published in England, is written with reference to the "Science and Art Department," but it has the more satisfactory feature of being also adapted to the use of practical working miners, quarrymen, and field geologists.

CORRESPONDENCE.

*** The Editor does not hold himself responsible for statements of facts or opinions expressed in Correspondence, or in Articles bearing the signature of their respective authors.

HYLOZOISM AND HYLO-IDEALISM.

THE supporters of any thesis which tends to revolutionise current ideas ought to give a patient hearing to every opponent, however gross may be his misconceptions and however abusive his language. I hope soon, with your kind permission, to answer Mr. Billing's late articles on Hylo-Idealism. At present I have only time to comment very briefly upon the letter of your correspondent "F. P. L." He falls into the usual confusion between the world as appearance and the world as actuality. Mountains, rivers, and seas, sun, moon, and stars, and the *phenomenal* human brain, are fashioned into the forms which we know by the *actual* human brain. What I find "nauseous" is the minification of man in comparison with the phenomenal universe which he procreates. The actuality of things is unknown to us, save by its manifestations in the sphere of sense and thought; but I have tried to show that these manifestations distinctly negative dualistic theories. I refer "F. P. L." to articles on "Animal Automatism," "The Identity of Vital and Cosmical Energy," "The Philosophy of Thomas Carlyle," in the "Journal of Science" for April, May, and June, 1882, and to "The Brain Theory of Mind and Matter" in the issue for March, 1883.

C. N. (CONSTANCE ARDEN).

THE TREATMENT OF LONDON SEWAGE.

MANY complaints have been made that nothing was done towards the purification of the immense volume of sewage poured into the Thames at Crossness and Barking Creek with every turn of the tide. Something is being done at last, and that something, if it effects nothing else, will make a very handsome addition to the present outlay without the possibility of any set-off. Chloride of lime, I believe from 100 to 180 tons daily, is being put into the river. As this material is worth £9 per ton,

the extra cost, at the lower figure, will be £328,500 yearly,—a heavy outlay for an injudicious measure. I call it injudicious because chloride of lime, though it may for the moment suppress or mask the evil odour of the sewage, will not remove from it the putrescent or putrescible matters, and unless this is done I need scarcely say that there can be no true and permanent purification.

Further, chloride of lime in rivers is itself a nuisance. It and its kindred compounds were specially noted in the "Recommendations" of the late Royal Rivers Pollution Commission as to be excluded, or at least kept within very narrow limits, amongst other grounds because it is fatal to fish. Disputes between riparian proprietors and the owners of paper-mills on this very subject are not infrequent. It is again to be remarked that chloride of lime and carbolic acid are mutually incompatible. Yet we see now the sanitary officials of the vestries pouring carbolic acid down public urinals, &c., whilst the Metropolitan Board of Works uses the conflicting ingredient at the outfalls, the ratepayers, of course, finding the funds for this unscientific procedure.

ARGUS.

TECHNICAL TRIALS.

I have not at present time to reply in full to the acute letter of "Nomikos." Much of it, however, relates to matter which lies outside both your cognizance and mine. A Homœopath defendant *qua* Homœopath is too rare a phenomenon to be taken into account. I am not aware of any scientific man who objects to Patent Laws as such. The persons who would do away with patent-right are lawyers, merchants, bankers, and the like. Should even some day a distinguished chemist or physicist, "without faith in the Patent Laws," turn up, it is scarcely likely that his objection to a system would interfere with his judgment as to the novelty or the feasibility of a process. There are scores of matters which might possibly form the subject of legal proceedings on which text-books are dumb.

In the cases of technical language which "Nomikos" brings forward there are synonyms intelligible to the public; but in many cases the technical term is the only one in existence for an object or a process, so the difficulty of explaining its meaning to outsiders is not small at any time, and is greatly increased by the system of examination and cross-examination.

AN OLD TECHNOLOGIST.

NOTES.

At the last meeting of the Entomological Society Mr. Waterhouse exhibited certain Coleoptera which had been exposed to the light, in show-cases, at the British Museum, in comparison with recent specimens of the same species. The change of colour was in some cases complementary, *e.g.*, in *Eurhinus cupreus* and in *Parapleura bacca*, from a fiery red to green.

An informal meeting of naturalists has recently been held at the British Museum to discuss the proposed introduction of a ternary nomenclature in place of the present binary (Linnæan) system. No resolution was proposed, but we may say that generally the innovation was supported by the ornithologists and opposed by the entomologists.

A special laboratory has been opened at Munich for the study of Bacteria.

The results lately obtained by Mr. Eglinton, at St. James's Hall, are simply astounding. Two clean slates are tied together with a morsel of pencil between them, and are held in such a manner that the medium cannot touch the inside with any part of his person. Yet a sound of writing is soon heard, and on unfastening the slates they are found covered with writing within!

Dr. Miklucho Maclay ("American Naturalist") states that the temperature of the body in *Echidna hystrix* is only 78° F.—much below that of normal mammals.

The "Courrier Medical" describes a fatal case of hydrophobia from the bite of a dog evidently not rabid. The patient had been bitten slightly, about three months before his admission to the hospital, by a pregnant bitch which was not mad, and which had since brought forth and suckled a litter of puppies. The owner of the animal admitted that this bitch when pregnant was evil-disposed, and attacked men and animals, whilst she had never been mad nor otherwise ill. The fear of hydrophobia was evidently not the cause of the symptoms observed, since the patient attached no importance to the bite which he had received, and did not even connect it with his illness. The writer adds that "it is prudent to mistrust dogs and cats when in the state

of heat or of gestation, and when [sick, and also when they become quarrelsome."

Colonel W. Hope, V.C., speaking of Government officials, says :—"Judgment and common sense they may be wanting in, but school-boy competitive-examination smartness they have any quantity of."

Mr. G. Brown-Goode ("Science") defends Dr. Günther against the charges brought by Prof. Gill. He shows that the *Challenger* collections have not yet become the property of the British Museum, but are merely held in trust by Dr. Günther for the Lords of the Admiralty.

A "Christian" organ, whilst complaining that trade, art, and "dissent" are not, as such, represented in the House of Lords, does not regret the comparative absence of Science in that august assembly.

Mr. W. R. Tomlinson, M.A. ("Light"), writes :—"I have long thought that the late Charles Darwin, who was a Scripture student, must have got his material ideas of the 'survival of the fittest' from the spiritual teaching of the Bible concerning the conditional immortality of the soul."

Mr. S. H. Trowbridge ("Science") records the capture of a shovel-nosed sturgeon (*Scaphirhynchops platyrhynchus*) which "exhibited on the surface no sign whatever of eyes." This species of fish ploughs in the mud for its food, and has little apparent use for eyes. Hence, as the author thinks, they are becoming obsolete.

MM. Pasteur, Chamberland, and Roux ("Comptes Rendus") consider that they have at last developed a vaccine for rabies. They have called upon the French Minister of Public Instruction to nominate a commission before whom the crucial demonstration is to be performed.

Mr. J. E. Jeffries ("Proc. Boston Natural Hist. Soc.") combats the current idea that scales, feathers, and hairs are identical in Nature.

M. A. Chauveau ("Comptes Rendus") considers it fully proved that condensed oxygen, as well as heat, attenuates the activity of virulent microbia. The precise degree of condensation is, however, the important point.

It is an error to suppose that the vapours of phenol, even when so strong as to be scarcely tolerable by human beings, will drive away the house-fly.

Dr. S. Lukjanow ("Zeitschrift für Physiol. Chemie") has demonstrated that the absorption of oxygen by animals is not a

function directly dependent on the oxygen-tension of the air, yet under certain circumstances the organism has the power of taking up from an atmosphere abnormally rich in oxygen more of this element than from common air.

Mr. Theodore Gill ("Science") complains emphatically that, though the deep-sea fishes of the *Challenger* Expedition have been in the hands of Dr. Günther for eight years, eminent ichthyologists are still refused access to them.

An "Anti-Vivisection Society" has sprung up in America. In reply to one of its manifestoes the Pennsylvania Medical Society adopted a resolution emphasizing the usefulness and necessity of physiological experimentation.

We are glad to learn that the "Illustrated London News" and the "Dispatch" have come forward in defence of physiological experimentation. These papers reach thousands of intelligent persons who never take up a medical or other scientific journal. The "Dispatch" says truthfully—"The Act of 1876 has resulted in almost extinguishing original physiological research in this country."

According to Dr. Pehl, bacteria in water may be very greatly reduced in number by keeping it in rapid motion.

The fifty-seventh meeting of "German Naturalists and Physicians" will take place at Magdeburg from the 18th to the 23rd of September.

The coming meeting of the British Medical Association at Belfast still occasions some disputes and heartburnings.

During the year 1883, according to the annual report just issued to Parliament, five hundred and sixty-nine experiments were performed on living animals in the United Kingdom, thirty-four of these being carried out in Ireland. Fifty-five experiments were performed without anæsthetics, and one hundred and twenty-two under certificates giving permission to preserve the life of the animal after recovery from anæsthesia. Concerning this last class of experiments the report states that in one hundred and fourteen cases the operation consisted of inoculation with various septic matters or morbific organisms, for the greater part connected with an important inquiry into the nature of tubercular affections. No pain was inflicted in these cases except in about fourteen or fifteen instances, in which disease was produced, but which was very trifling. In the remaining eight cases, in which more serious operations were required, as these were effected under anæsthesia, the only suffering in the animals that survived would be that which attends the ordinary repair of a "surgical injury."

Dr. Testut laid before the French Academy of Sciences an account of the dissection of a South African Bushman. Several Simian characteristics in the arrangement of the muscles were pointed out; yet M. de Quatrefages, strangely enough, thought proper to regard these facts as arguments *against* the animal origin of man!

M. V. Marcano ("Comptes Rendus") has observed that plants in tropical regions evaporate during the night (from 6 p.m. to 6 a.m.) a quantity of water equal to that which they exhale by day. The daily evaporation takes place chiefly in the morning, the maximum being generally between 10.15 a.m. and noon. The hygrometric condition of the atmosphere has no decided influence on this phenomenon.

According to Rossi ("Giornale della Accademia di Medicina") not only the Cantharidæ, but the Cetoniadæ, and hence probably other groups of Coleoptera, secrete cantharidine.

P. Giacosa ("Revista di Chimica") states that beetles (group not mentioned) contain 7·7 per cent of fatty matter, which melts at 29° to 30° C., and contains 73·6 of carbon and 11·4 of hydrogen.

It is noteworthy that the best solvent for cantharidine is formic acid,—a very frequent secretion among insects.

MM. Gautier and Etard consider the odour of the ptomaines similar to that of whitethorn or sloe blossom.

M. F. Krasen ("Ciel et Terre" and "Annuaire Botanique") seeks to demonstrate that certain anomalies in the distribution of plants, according to altitude, must be due to a comparatively recent change in the elevation of the mountains on which they grow.

In the official report issued by the Sanitary Board of Paris, in view of a possible visitation of cholera, the public are cautioned against raw vegetables, especially those cultivated on the great sewage-irrigation farm of Gennevilliers! What will be said in Croydon?

Mr. L. F. Ward ("Science") asks strangely:—"Why, then, does not politics form a legitimate subject of scientific investigation? Why might not its discussion in strictly scientific societies and journals be permitted and encouraged?" We reply, Because there is already far too much of such discussion; that it already absorbs too great a share of public attention—especially since 1876—to the disadvantage of Science; and because such "permission and encouragement" would drive away men of things and substitute for them wordmongers.

Mr. S. Newcomb ("Science"), in criticising President Eliot's views on a "liberal education," outdoes Procrustes. He suggests that "the end will be best reached by adopting a system of training for every man in that class of subjects for which his natural capacity is the weakest!" Surely a "community and sympathy of thought and feeling among the great body of educated men" would be far too dearly bought on such terms!

M. Montigny maintains that the occurrence of blueness in the scintillation of the stars serves, to some extent, as a measure of the quantity of water contained in the upper regions of the atmosphere.

The *Narcissus reflexus* of the Glenan Islands is polymorphous, presenting a form with the style long and the stamens shorter; a second form in which the style is short and the stamens longer; and a third, very rare form, in which the three internal stamens are abortive.

H. H. Smith ("American Naturalist") mentions a Longicorn genus (*Scorpionus*), found in South Brazil, which can inflict a sharp sting with the terminal joint of its antennæ.

The "American Naturalist" mentions that a farmer in Arkansas was stung to death by the "buffalo gnat,"—a species of *Simulium*.

The "Medical Press and Circular," speaking of the Medical Bill at present before Parliament, says that Messrs. Hopwood and Wyndham have amendments for the encouragement of quackery, which need not be seriously considered.

Perfectly pure albumen does not coagulate at 212° F., and forms no precipitate with the salts of barium.

We perceive that the Chemical Society of Paris proposes to assume the title of the "Chemical Society of France."

According to the "Scientific American" it would require four thousand years for the waters of the Mediterranean to fill the valley of the Jordan, if admitted through a channel 100 feet wide by 25 feet in depth. At the same rate it would take 40,000 years to fill up the Caspian to the sea-level, and thousands of years to fill up the Sahara.

[As by far the greater part of the Sahara is above the sea-level the author's calculations are evidently ill-founded in this respect.]

Dr. C. G. Garrison ("Medical Bulletin") contends that "as expert the position of the physician is judicial, and he should be called by the Court, not by the contestants."

[The same must, by a parity of reasoning, be the case with the microscopist, the scientific chemist, and the engineer.]

Says the "Medical Times and Gazette"—"There are two considerations that will give additional importance to M. Pasteur's discovery, should it prove to be a genuine one. In the first place it will immensely stimulate research in connection with analogous diseases, for which it is to be hoped a similar preventive may be found. . . . In the second place, M. Pasteur's success will be a blow to the anti-vivisection agitation. It will make, or ought to make, every dog-lover the friend of experimental physiology; for even the most rabid anti-vivisectionists must admit that rabid dogs would in all probability have existed to the Greek Kalends, if they had had their way in France as well as in England."

The Abbé François Moigno, for many years editor of "Cosmos les Mondes," died on July 13th. If, on the one hand, he was an obstinate opponent of Evolution, he merits great honour, on the other, as a champion of free Science against bureaucracy.